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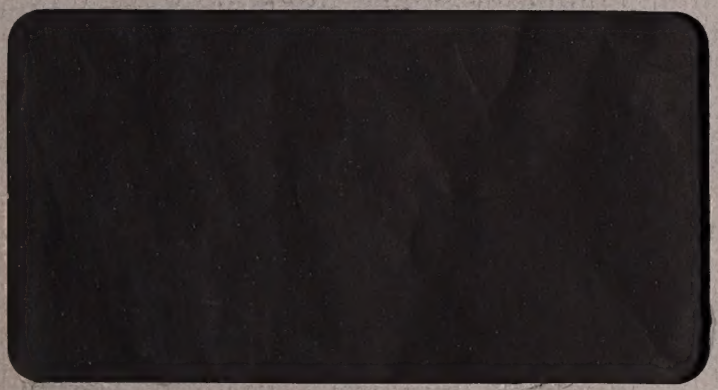
# HANDBOOK
# OF
# OPERATING INSTRUCTIONS



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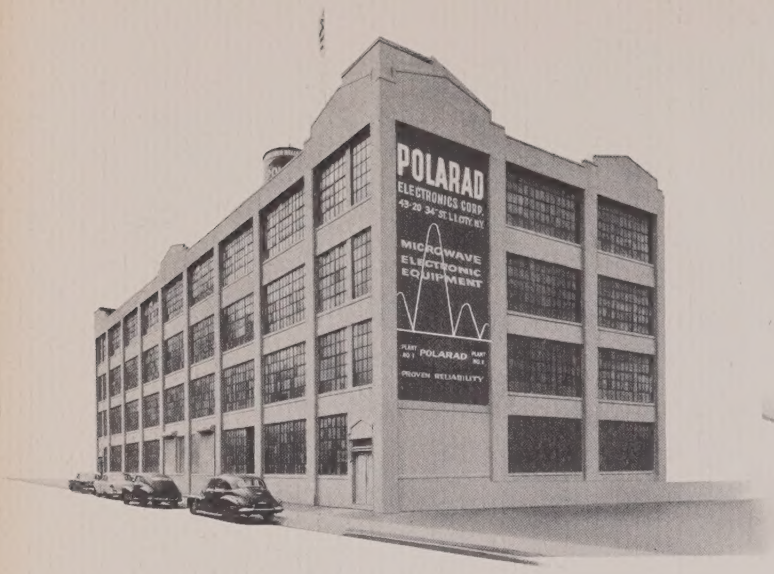


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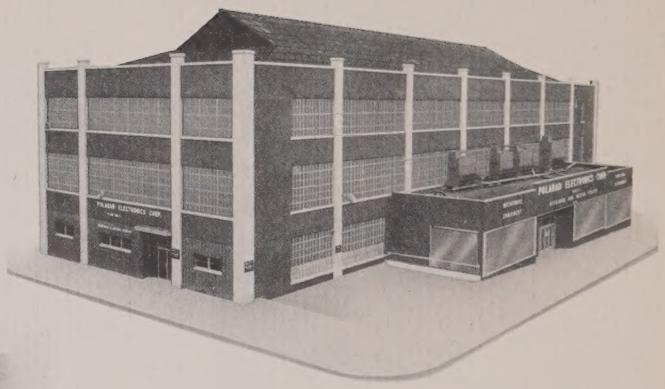

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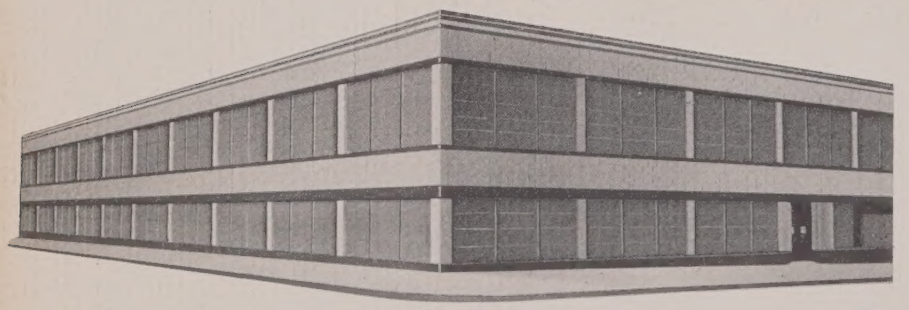

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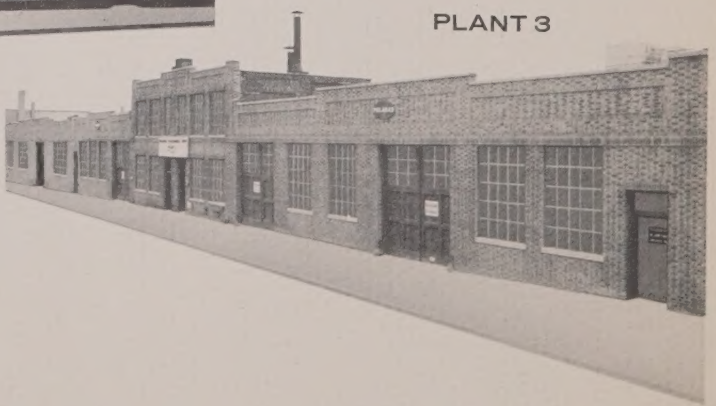

**POLARAD ELECTRONICS CORPORATION** 43-20 34th STREET, LONG ISLAND CITY 1, N. Y.

POLARAD

PROVEN RELIABILITY

# INSTRUCTION MANUAL

## MICROWAVE SIGNAL GENERATOR

## MODEL MSG-34

### 4,200 MC TO 11,000 MC

POLARAD ELECTRONICS CORPORATION

43-20 34th STREET • LONG ISLAND CITY 1 • NEW YORK, N. Y.

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# TABLE OF CONTENTS


| SECTION | | | PAGE |
|---|---|---|---|
| **1.** | **INTRODUCTION** | | |
| 1-1. | Scope of Manual | | 1 |
| 1-2. | Purpose and Use of the Equipment | | 1 |
| 1-3. | General Description | | 1 |
| 1-4. | Technical Characteristics | | 1 |
| 1-5. | Electron Tube Complement | | 3 |
| 1-6. | Accessories Supplied | | 3 |
| **2.** | **OPERATION** | | |
| 2-1. | Function of Controls | | 4 |
| 2-2. | Operating Instructions | | 6 |
| **3.** | **PRINCIPLES OF OPERATION** | | |
| 3-1. | General | | 7 |
| 3-2. | Beam Supply | | 7 |
| 3-3. | Repeller Supply | | 8 |
| 3-4. | Keyer Supply | | 8 |
| 3-5. | Modulator Power Supply | | 8 |
| 3-6. | +210V Supply | | 8 |
| 3-7. | Klystron Oscillator Circuit | | 8 |
| 3-8. | Power Monitoring Circuit | | 8 |
| 3-9. | Attenuator | | 13 |
| 3-10. | Modulated Operation | | 13 |
| 3-11. | Internal Modulation | | 13 |
| 3-12. | Rate Generator Circuit | | 14 |
| 3-13. | Undelayed Sync Blocking Oscillator | | 14 |
| 3-14. | Delay Phantastron | | 14 |
| 3-15. | Delayed Sync Blocking Oscillator | | 15 |
| 3-16. | Width Multivibrator | | 15 |
| 3-17. | Cathode Follower | | 15 |
| 3-18. | Pulse and Keyer Amplifiers | | 15 |
| 3-19. | External Sync Circuit | | 15 |
| 3-20. | External Sync Modulation | | 15 |
| 3-21. | FM Modulation | | 16 |
| 3-22. | Protective Relays | | 16 |
| 3-23. | Functional Operation of the Mechanical Components | | 16 |
| **4.** | **MAINTENANCE** | | |
| 4-1. | General | | 18 |
| 4-2. | Access to Equipment | | 18 |
| 4-3. | Preliminary Inspection Procedures | | 18 |
| 4-4. | Trouble Shooting | | 20 |
| 4-5. | Checking the DC Power Supplies | | 28 |
| 4-6. | Checking Relays K101 and K102 | | 28 |
| 4-7. | Replacement of RF Klystron Oscillator Tube | | 28 |

# TABLE OF CONTENTS (CONTINUED)


SECTION PAGE

5. ADJUSTMENT AND ALIGNMENT

5-1. Power Supply Adjustments . . . . . 30
5-2. Repeller Voltage Tracking Procedure . . . . . 31
5-3. Tracking Adjustment After Replacement of a Track Potentiometer . . . . . 33
5-4. Frequency Dial Calibration . . . . . 34
5-5. Setting the LOW FREQ ADJ R217. . . . . 34
5-6. Setting the SYMMETRY ADJ R211 . . . . . 34
5-7. Setting the MIN DELAY ADJ R233 . . . . . 35
5-8. Setting the MIN WIDTH ADJ R315 . . . . . 35
5-9. Setting the BIAS ADJ R309 . . . . . 35
5-10. Setting the BIAS ADJ R131 . . . . . 35


# LIST OF ILLUSTRATIONS


FIGURE PAGE

Frontispiece Signal Generator MSG-34 and Accessories . . . . . iv
1-1. Signal Generator MSG-34, Front Panel. . . . . 2

2-1. Maximum Pulse Delay versus Pulse Repetition Frequency . . . . . 5

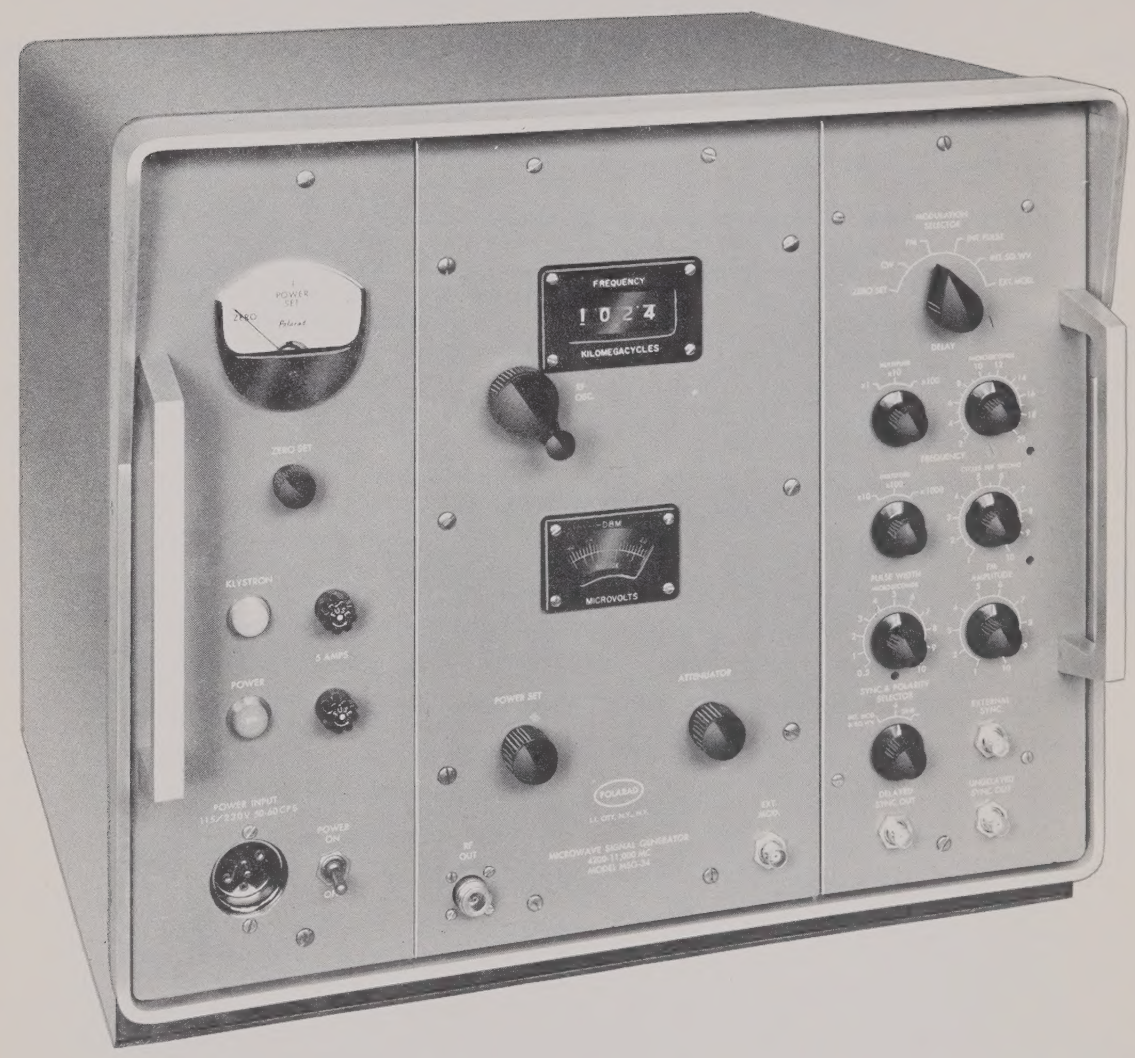
3-1. Signal Generator MSG-34, Block Diagram. . . . . 9/10
3-2. Power Supplies, Block Diagram . . . . . 11
3-3. Klystron Oscillator, Simplified Schematic Diagram . . . . . 12
3-4. Repeller Voltage Characteristic Chart . . . . . 13
3-5. Signal Generator MSG-34, Electro-Mechanical Schematic Diagram . . . . . 16

4-1. Signal Generator MSG-34, Side View Right . . . . . 23
4-2. Signal Generator MSG-34, Side View Left . . . . . 23
4-3. Modulator Power Supply, Top View . . . . . 24
4-4. Modulator Power Supply, Bottom View . . . . . 24
4-5. Modulator Assembly, Component Layout . . . . . 25
4-6. Repeller and Beam Chassis, Top View . . . . . 26
4-7. Repeller and Beam Chassis, Bottom View . . . . . 26
4-8. RF and Keyer Supply . . . . . 27
4-9. Oscillator Cavity, Exploded View . . . . . 29

5-1. Repeller Voltage Tracking, Test Set-Up . . . . . 32
5-2. Modulator Phase Shifting Circuit, MK-1, Schematic Diagram . . . . . 32
5-3. Typical Mode Patterns . . . . . 35
5-4. Oscillator Adjustable Tuning Cam, Component Location Diagram . . . . . 36
5-5. Adjustments, Test Set-Up . . . . . 36
5-6. Modulator Section, Schematic Diagram . . . . . 37/38
5-7. Signal Generator MSG-34, Overall Schematic Diagram, Less Modulator . . . . . 39/40

# LIST OF TABLES


| TABLE. | | PAGE |
|---|---|---|
| 1-1. | Electron Tube Complement | 3 |
| 2-1. | Operating Controls | 4 |
| 2-2. | Modulation Control Settings | 6 |
| 3-1. | Setting for Repetition Frequency Ranges | 14 |
| 4-1. | Preliminary Inspection Procedure | 18 |
| 4-2. | Trouble Shooting | 20 |
| 4-3. | Power Supply Voltages | 28 |
| 4-4. | Relays Energized | 28 |
| 5-1. | Adjustments, Power Supplies | 30 |
| 5-2. | Test Equipment Required for Repeller Tracking Procedure | 31 |




Signal Generator MSG-34

# SECTION 1
# INTRODUCTION

## 1-1. Scope of Manual

This instruction manual contains directions for the operation and maintenance of the Ultra Broadband Microwave Signal Generator, Model MSG-34 (Frontispiece), designed, developed, and manufactured by the Polarad Electronics Corporation of Long Island City, New York.

## 1-2. Purpose and Use of Equipment

The Polarad Model MSG-34 Ultra Broadband Microwave Signal Generator is a precision instrument designed to generate cw, fm, and pulse-modulated radio frequency energy over the range from 4,200 mc to 11,000 mc. The Model MSG-34 provides a means of testing and alignment of broad and narrow band microwave systems and components, such as antennas, attenuators, beacons, crystal mounts, hybrid junctions, preselectors, radars, receivers, and traveling wave tube amplifiers. Specific measurements that can be taken include bandwidth, attenuation, frequency dial calibration, image rejection, sensitivity, power gain, and VSWR.

## 1-3. General Description

The Model MSG-34 Signal Generator is a versatile instrument which combines high accuracy. simplicity of operation, and portability in a single unit. A broadband external klystron cavity enables continuous tuning over the complete frequency range of the instrument. The equipment is designed in four major sub-assemblies; an rf and keyer section, a modulator power supply, a repeller and beam supply, and a modulator section. The basic unit contains the power transformers, filters, switches and meter. Each sub-assembly is a separate unit equipped with plugs and receptacles for connecting the sub-assemblies to each other and to the basic unit to make up the complete MSG-34 equipment. This method of construction facilitates servicing and alignment procedures.

## 1-4. Technical Characteristics

Power Input . . . . . 115v-230v ±10%, 50-60 cps, 300 watts.
Frequency Range . . . . . 4,200 mc to 11,000 mc ±1%.
Power Output . . . . . 1 mw (0 dbm) calibrated (±2.5 dbm at certain frequencies).

Attenuator Output
- Range . . . . . 0 dbm to -127 dbm, 0.223 volt to 0.1 microvolt (directly calibrated).
- Accuracy . . . . . ±2.5 db from 0 to -127 dbm.

Output Impedance . . . . . 50 ohms nominal.
Output VSWR . . . . . 2:1 maximum.
Modulation . . . . . Internal or external pulse, square wave or fm.
Output Connector . . . . . Type N.
Unit Size . . . . . 19-1/4 in. wide by 15-1/16 in. high by 19-13/16 in. deep.
Weight . . . . . 114 lbs.

Internal Pulse Modulation:
- Width . . . . . 0.2 to 10 microseconds.
- Repetition Rate . . . . . 10 to 10,000 pps.
- Delay . . . . . 2 to 2,000 microseconds.
- Sync . . . . . Internal, external-pulse, or sine wave.
- Rise Time . . . . . 0.1 microsecond as measured between 10% and 90% of maximum amplitude of the initial rise.
- Decay Time . . . . . 0.1 microsecond as measured between 10% and 90% of maximum amplitude of the final decay.

Internal Square Wave Modulation:
- Rate . . . . . 10 to 10,000 pps.
- Symmetry . . . . . ±5%.
- Sync . . . . . Internal.

Internal Frequency Modulation:
- Type . . . . . Linear sawtooth.
- Frequency Deviation. . . . . 5 mc minimum.
- Rate . . . . . 10 to 10,000 cps.
- Sync . . . . . Internal or external, pulse or sine wave.

External Pulse Modulation:
- Polarity . . . . . Positive or negative.
- Rate . . . . . 10 to 10,000 pps.
- Pulse Width . . . . . 0.2 to 100 microseconds.
- Amplitude . . . . . 10 to 40 volts peak.

Output Sync Pulses:
- Polarity . . . . . Positive, delayed and undelayed.
- Rate . . . . . 10 to 10,000 pps.
- Amplitude . . . . . 15 volts peak minimum.
- Rise Time . . . . . Less than 0.1 microsecond.
- Width . . . . . 0.25 microsecond.

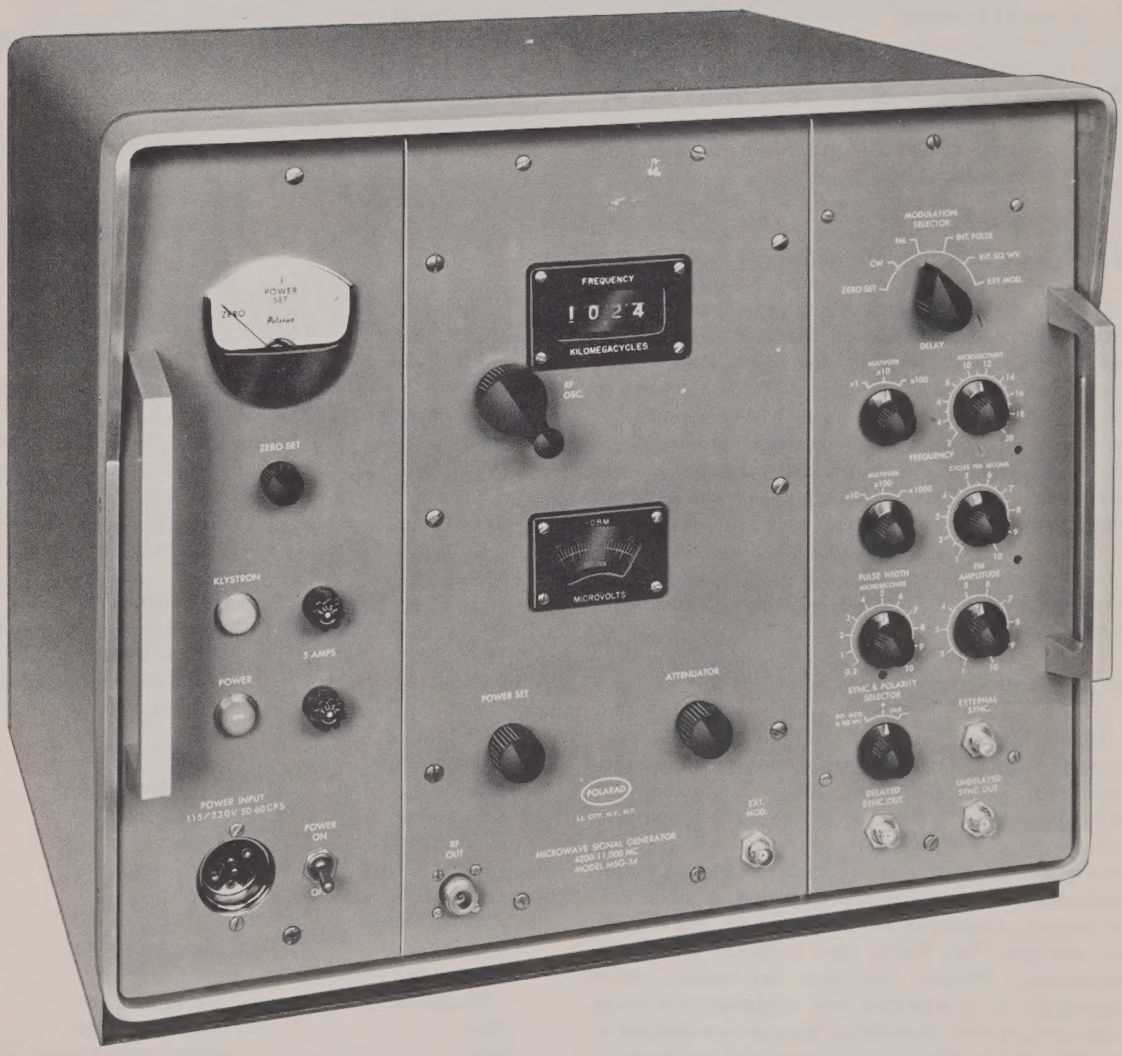



Figure 1-1. Signal Generator MSG-34, Front Panel

External Sync:

| | |
|---|---|
| Type of Input . . . . . | Positive, negative, or sine wave. |
| Amplitude . . . . . | Pulse: 5 to 50 volts peak. Sine wave: 5 to 40 volts rms. |

1-5. TABLE 1-1. ELECTRON TUBE COMPLEMENT.

| Ref Symbol | Tube Type | Function |
|---|---|---|
| V1 | 5R4GY | Rectifier |
| V2 | 5R4GY | Rectifier |
| V3 | 5933 | Series Regulator |
| V4 | 12AX7 | DC Amplifier |
| V5 | 5651 | Voltage Regulator |
| V6 | 5651 | Voltage Regulator |
| V7 | 5R4GY | Rectifier |
| V8 | 6AR6 | Series Regulator |
| V9 | 12AT7 | DC Amplifier |
| V10 | 5651 | Voltage Regulator |
| V11 | 0A2 | Voltage Regulator |
| V12 | 0A2 | Voltage Regulator |
| V13 | 5Y3 | Rectifier |
| V14 | 6AR6 | Series Regulator |
| V15 | 12AX7 | DC Amplifier |
| V16 | 0B2 | Voltage Regulator |
| V17 | 5Y3 | Rectifier |
| V18 | 6080 | Series Regulator |
| V19 | 12AX7 | DC Amplifier |
| V20 | 0A2 | Voltage Regulator |
| V101 | 6X4W | Protective Diode |
| V102 | 5721 | Klystron Oscillator |
| V103 | 6X4 | Rectifier |
| V104 | 6AR6 | Series Regulator |

| Ref Symbol | Tube Type | Function |
|---|---|---|
| V105 | 12AX7 | DC Amplifier |
| V107 | 6AH6 | Pulse Amplifier |
| V108 | 6CL6 | Keyer Amplifier |
| V109 | 6AH6 | Phase Inverter |
| V201 | 5725 | Phantastron Rate Generator |
| V202 | 12AU7 | A-Coupling Amplifier<br>B-Coupling Amplifier |
| V203 | 5725 | Phantastron Rate Generator |
| V204 | 12AT7 | A-Cathode Follower<br>B-Buffer Amplifier |
| V205 | 5725 | Delay Phantastron |
| V206 | 5687 | A-Blocking Oscillator<br>B-Blocking Oscillator |
| V207 | 12AT7 | A-Phase Inverter<br>B-Clipper Amplifier |
| V208 | 12AU7 | Schmitt Trigger |
| V209 | 5687 | A-Puller Amplifier<br>B-Undelayed Blocking Oscillator |
| V210 | 12AU7 | Cathode Follower |
| V211 | 6AN8 | Width Multivibrator |

## 1-6. Accessories Supplied

1 - AC Line Cord, part No. B111144.
1 - RF Cable, part No. BP12551.
1 - Video Cable, part No. BP12553.
1 - Wrench Kit.

# SECTION 2
# OPERATION

## 2-1. Function of Controls

Table 2-1 lists the panel designations of operating controls, indicators, connectors, and their functions. Refer to figure 1-1 for the location of the above.

TABLE 2-1. OPERATING CONTROLS.

| Controls, Indicators, or Connectors | Function |
|---|---|
| POWER INPUT 115/230V 50-60 CPS receptacle | Connects signal generator to 115V-230V 50-60 CPS source. |
| POWER ON-OFF switch | A double-pole, single-throw switch to apply ac power. |
| POWER indicator (White) | Glows when the POWER ON-OFF switch is in ON position. |
| KLYSTRON indicator (Red) | Upon completion of a 60 second delay cycle the KLYSTRON (Red) indicator lamp lights. |
| MODULATION SELECTOR switch | Permits selection of cw, fm, square wave or pulse modulated output (internal or external). |
| ZERO SET control | Permits balancing of the internal thermistor bridge so that the meter indicates ZERO. |
| POWER SET control | Permits adjustment of the cavity so that meter indicates POWER SET. |
| RF OSC. control and FREQUENCY IN KILOMEGACYCLES dial | Rotates the FREQUENCY IN KILOMEGACYCLES dial to set desired frequency. |
| RF OUT connector | Connects the rf output from the attenuator to the equipment under measurement. |
| ATTENUATOR control and -DBM MICROVOLTS dial | Reduces the rf output voltage to known levels below a measured reference level as indicated on the -DBM MICROVOLTS dial. |
| SYNC. & POLARITY SELECTOR switch | INT. MOD. & SQ. WV. position:<br>a. Repetition rate for FM SQ. WV. and INT. PULSE is controlled by internal FREQUENCY control.<br>b. Enables DELAY, FREQUENCY, and PULSE WIDTH controls when MODULATION SELECTOR switch is set to INT. PULSE.<br>c. Enables FREQUENCY control when MODULATION SELECTOR switch is set to INT. SQ. WV. position.<br><br>+, -, or SINE (+or -) positions:<br>a. Repetition rate is determined by an external positive or negative pulse, or a sine wave.<br>b. Enables DELAY and PULSE WIDTH controls when MODULATION SELECTOR switch is set to INT. PULSE. |
| DELAY MICROSECONDS and MULTIPLIER controls | Permits adjustment of the delay between the rf output pulse and the undelayed sync pulse over the range from 2 to 2,000 microseconds, but not |

TABLE 2-1. OPERATING CONTROLS (Continued).

| Controls, Indicators, or Connectors | Function |
|---|---|
| | greater than 75% of the pulse period, as shown in figure 2-1. |
| FREQUENCY CYCLES PER SECOND and MULTIPLIER controls | Determines the modulation repetition rate when the SYNC. & POLARITY SELECTOR switch is in INT. MOD. SQ. WV. position. |
| PULSE WIDTH MICROSECONDS control | Permits adjustment from 0.2 to 10 microseconds of the rf pulse width when MODULATION SELECTOR switch is in INT. PULSE position. |
| FM AMPLITUDE control | Sets the magnitude of the sawtooth signal applied to the repeller of the reflex klystron oscillator when MODULATION SELECTOR switch is in FM position. |
| EXT. MOD. connector | Permits the signal generator to be connected to a source of external modulating voltage when MODULATION SELECTOR switch is in EXT. MOD. position and SYNC. & POLARITY SELECTOR switch is in + or -, depending on the polarity of the external signal. |
| EXTERNAL SYNC. connector | Used to synchronize the signal generator with a sine wave or pulse sync signal from external equipment, when MODULATION SELECTOR switch is placed in FM or INT. PULSE position, and SYNC. & POLARITY SELECTOR switch to the position which corresponds with the type of external sync signal applied. |
| DELAYED SYNC. OUT connector | Supplies positive trigger in time coincidence with rf pulse when MODULATION SELECTOR switch is in FM or INT. PULSE position. |
| UNDELAYED SYNC. OUT connector | Supplies positive trigger which leads the rf pulse in time when MODULATION SELECTOR switch is in FM or INT. PULSE position. |

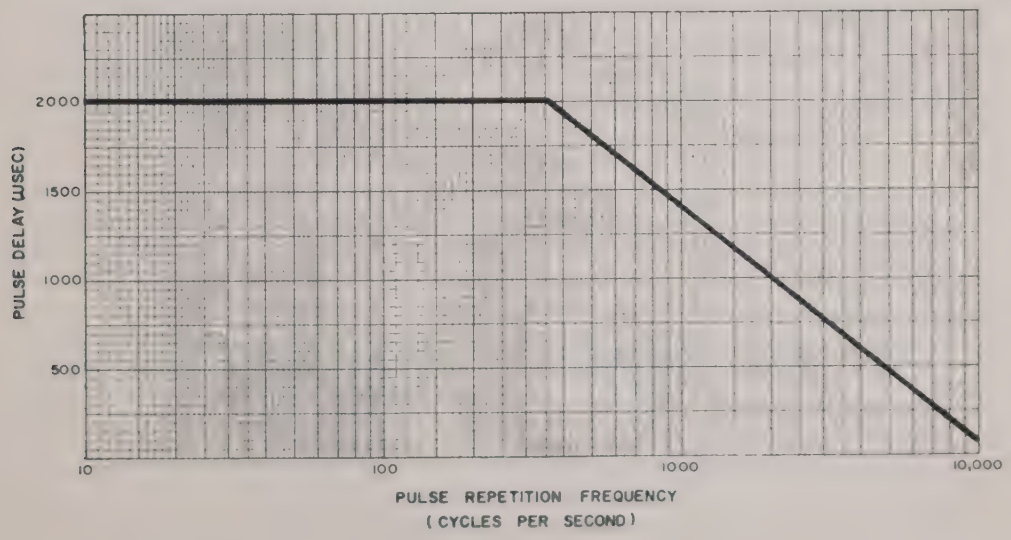



Figure 2-1. Maximum Pulse Delay versus Pulse Repetition Frequency

## 2-2. Operating Instructions.

The following instructions are to be followed to ensure proper operation of the MSG-34.

a. Starting Instructions.

1) Measure the line voltage to determine whether it is nominally 115 volts or 230 volts. The 115v-230v input switching system of the unit is normally factory set at 115 volts. If it is desired to use 230 volts as input to the unit, the internal input switching system must be set at 230 volts. Refer to paragraph 5-1a for the operation of this switch.

2) Connect a 115v or 230v 50-60 cps, single phase power source to the POWER INPUT 115/230V 50-60 CPS receptacle, using the ac line cord supplied.

3) Throw the POWER ON-OFF switch to the ON position. The front panel POWER indicator (white) should light.

4) Allow the signal generator to warm up for at least 15 minutes.

b. Setting Frequency and Power Calibration.

In order to calibrate the output power the succeeding steps must be followed.

1) Rotate the RF OSC. control until the FREQUENCY IN MEGACYCLES dial indicates the desired operating frequency.

2) Set MODULATION SELECTOR switch to ZERO SET position. This makes the rf oscillator inoperative.

3) Adjust ZERO SET control until the meter pointer is at ZERO.

4) Set MODULATION SELECTOR switch to CW.

5) Adjust POWER SET control until the meter pointer is at POWER SET. The signal generator is now at the one-milliwatt power reference level for the frequency set in step 1.

6) Rotate the ATTENUATOR control until the attenuator dial is set to the desired value of rf signal level. The output level is expressed in decibels below one milliwatt, working into a resistive load of 50 ohms, on the top scale, and is either millivolts or microvolts, as marked on the lower scale.

**NOTE**

Whenever the setting of the frequency dial is changed, it is necessary to repeat the calibration procedure, as given above, in order to determine the power output.

c. Modulation Control Settings.

The control settings to obtain the various types of modulation available, are listed in Table 2-2. If the instructions of paragraph b have been followed, the output in CW will be average power and the output in PULSE and SQ. WV. will be peak power.

d. Pulse Delay Versus Pulse Repetition.

Figure 2-1 shows the maximum permissible setting of the DELAY controls for pulse repetition rates within the pps range of the equipment. A delay setting greater than depicted by the curve will result in a false indication.

TABLE 2-2. MODULATION CONTROL SETTINGS

| OUTPUT | | RATE CONTROL | CONNECTED AT | MODULATION SELECTOR SETTING | SYNC. & POLARITY | REMARKS |
|---|---|---|---|---|---|---|
| RF | SYNC PULSE | | | | | |
| 1. CW | None | - - - | - - - | CW | - - - | - - - |
| 2. Pulse Modulated | Delayed or Undelayed | FREQUENCY control | - - - | INT. PULSE | INT. MOD. SQ. WV. | Pulse width and Delay, use as required |
| | None | External source | EXT. MOD. | EXT. MOD. | - or + | - - - |
| | Delayed or Undelayed | External source | EXTERNAL SYNC. | INT. PULSE | -, + or SINE | Pulse width and Delay, use as required |
| 3. Square Wave Modulated | Delayed or Undelayed | FREQUENCY control | - - - | INT. SQ. WV. | INT. MOD. & SQ. WV. | - - - |
| 4. FM | Delayed or Undelayed | FREQUENCY control | - - - | FM | - - - | FM Amplitude use as required |
| | Delayed or Undelayed | External source | EXTERNAL SYNC. | FM | -, + or SINE | FM Amplitude use as required |

# SECTION 3
# PRINCIPLES OF OPERATION

## 3-1. General

The basic principles of the Polarad Microwave Signal Generator, MSG-34, can be understood from the block diagram shown in figure 3-1. The signal generator provides continuous-wave, pulse-modulated, and frequency-modulated signals of known intensity and frequency in the range from 4,200 to 11,000 mc. The signal generator consists essentially of an rf reflex klystron oscillator, a modulator, a keyer, a power-monitoring bridge circuit, and five self-contained power supplies.

a. The klystron rf oscillator consists of a reflex klystron tube and its associated external cavity which generates the desired signal. The function of the modulator and keyer is to generate a modulation voltage, either pulse, square wave, or sawtooth in waveform, and to apply this voltage to the reflex klystron oscillator tube. When pulse or square wave amplitude modulation is used, the amplitude modulated signal is applied to the grid of the klystron tube. When frequency modulation is used, the sawtooth signal from the modulator is applied to the repeller electrode of the klystron tube. The signal generator is a free-running pulse generator when the SYNC. & POLARITY SELECTOR switch is in the INT. MOD. & SQ. WV. position and the MODULATION SELECTOR switch is in either the INT. PULSE, INT. SQ. WV. or FM internal positions. Provision is made for synchronizing the modulation voltage with an externally applied sine wave, or a positive negative pulse signal, through the EXTERNAL SYNC. receptacle. Provision is also made to modulate the reflex klystron oscillator tube with an external pulse signal, either single pulse or multi-pulse, through the EXT. MOD. receptacle.

b. In addition to producing an rf test signal at the equipment front panel RF OUT receptacle, the signal generator also produces video synchronizing triggers. These positive polarity triggers are available at the UNDELAYED SYNC. OUT and DELAYED SYNC. OUT receptacles.

c. The RF OSC. knob controls the movement of a non-contacting plunger within the cavity, and the tracking potentiometer which varies the klystron reflector voltage.

d. The power monitor consists of a bridge circuit in which a sliding thermistor probe (positioned by the POWER SET control) is one arm of the bridge. The probe is located in one of the two waveguide-beyond-cutoff tubes which project from the sides of the klystron cavity. Re-positioning the thermistor probe affects the power absorbed by the thermistor, thereby changing its resistance. Consequently, the bridge is unbalanced and a pointer deflection on the (POWER SET) meter is noted. The one-milliwatt power reference level is established, first, by balancing the bridge with no rf power applied, and second, by adjusting the thermistor until the pointer on the meter deflects to the POWER SET position. A sliding pick-up loop in the other waveguide-beyond-cutoff tube is employed to set the rf power output. This adjustment is controlled by the front panel ATTENUATOR knob when the power reference level has been set, and the -DBM dial reads "0", at which time one milliwatt of rf power is available at the RF OUT receptacle J101. When the MODULATION SELECTOR switch is in ZERO SET position, there is no rf output available at the RF OUT receptacle.

e. Five separate power supplies (see figure 3-2) are incorporated in the signal generator: 1. The BEAM SUPPLY provides the necessary anode to cathode voltage for the klystron; 2. The REPELLER SUPPLY provides the necessary voltage to the tracking potentiometer which varies the klystron cathode to repeller voltage; 3. The KEYER SUPPLY provides the necessary voltages for the keyer circuit, and sets the klystron grid bias; 4. The +210V SUPPLY provides the B+ voltage for the internal modulator; 5. The MODULATOR SUPPLY provides the necessary voltage to the power monitor bridge, plus the bias for the modulator.

## 3-2. Beam Supply (See figure 5-7.)

The function of the beam supply is to supply the necessary voltages and currents to the interaction grids of reflex klystron V102, so they can be maintained at a positive potential with respect to the cathode. Since the interaction grids contact the klystron oscillator barrel assembly, it is safer to ground the positive side of the power supply. The beam supply consists of a voltage doubler V1 and V2, a series regulator V3, an amplifier V4, and two voltage regulator tubes V5 and V6. The screen of V3 has B+ applied to it from the +210V supply. Control grid voltage for the dc amplifier section of V4 is obtained from the power supply through the -1250V ADJ. potentiometer R8, part of the power supply bleeder. The potentiometer is a screwdriver adjustment which sets the voltage output of the power supply to the required level.

### 3-3. Repeller Power Supply (See figure 5-7.)

The function of the repeller supply is to furnish a repeller voltage which is always negative with respect to the klystron cathode. In order to make the repeller voltage negative with respect to the cathode, the positive side of the repeller supply is tied to the negative output of the beam supply. Thus, though the total output variation from the circuit is 600 volts, the absolute potential varies from -1250 volts to -1850 volts. Screwdriver adjustment potentiometer R31 is used to set the -1850 volt output which supplies the repeller tracking circuit. A fixed -1400 volt is available at the anode of V12, and is used as a common reference voltage for the cathodes of the keyer power supply and keyer circuit. The -1550 volts at the cathode of V12 supplies negative bias and reference voltage for the keyer supply and keyer circuit with respect to the -1400 volt line. The repeller supply consists of rectifier V7, series regulator V8, amplifier V9, and voltage regulators V10, V11, and V12.

### 3-4. Keyer Power Supply (See figure 5-7.)

The keyer supply furnishes B+ voltage for the plates and screens of the keying circuit, and sets the klystron grid bias when the signal generator is set up for cw operation. The keyer supply is capable of supplying 150 to 170 volts. The voltage setting depends upon the klystron bias needed to allow 18-20 ma of beam current to flow in the klystron oscillator. BEAM CURRENT ADJ. potentiometer R127 is used to set the klystron grid bias in cw operation. The keyer power supply consists of V103, a full-wave rectifier, V104, a series regulator, and V105, a combination dc amplifier and voltage control. The negative side of this supply is referenced to the -1400 volt line and is taken from a fixed reference point in the repeller supply.

### 3-5. Modulator Power Supply (See figure 5-7.)

The modulator power supply furnishes a constant -108 volts to balance the bridge circuit, and also supplies bias voltage for the internal modulator. Full-wave rectification is accomplished by V13. V14 serves as a series regulator, while V15 serves as a dc amplifier and voltage control tube. Tube V16 provides reference voltage for the regulator circuit.

### 3-6. +210V Power Supply

The +210V supply, which is part of the modulator supply, furnishes B+ for the modulator circuit. It also supplies the power to energize HOLD RELAY K2 through DELAY RELAY K1, when the normally open contacts (3 and 8) close. Rectification is accomplished by V17, while V19 serves as a dc amplifier and voltage control tube. Reference voltage is supplied by V20. +210V ADJ potentiometer R63 permits the voltage output of the power supply to be set to the required level.

### 3-7. Klystron Oscillator Circuit

The oscillator circuit uses a reflex klystron tube, operating in an external tuned cavity, to generate cw signals (see figure 3-3). The cavity is in the form of a coaxial transmission line, and consists of two cylinders, one inside the other. The klystron tube is inserted at one end of this line so that the outer cyclinder makes contact with the first interaction grid (so termed because it is closer to the cathode), while the inner cylinder makes contact with the second interaction grid. At the other end, the resonator "short" circuit is completed by a movable noncontacting plunger of special electrical design. The RF OSC. knob on the front panel controls the movement of the plunger within the cavity to set the resonant frequency. Simultaneously, this control adjusts the tracking potentiometer which applies the proper voltage to the klystron repeller to insure operation within its repeller mode. Two waveguide-beyond-cutoff tubes, projecting from the cavity, couple rf energy to the attenuator and the power monitor.

Protective diode V101 is connected between the klystron repeller and cathode, and keeps the repeller from going positive with respect to the cathode.

The necessary conditions for oscillation at resonant frequencies are obtained when the klystron oscillator is operated in the 4-3/4 and 2-3/4 cycle repeller mode and the 3/4 wavelength cavity mode. Figure 3-4 is a graph showing oscillating frequencies plotted against a range of repeller voltages. This cavity frequency characteristic curve represents the repeller mode as it is determined by the tracking of the plunger (choke) and potentiometer R101, and gives the settings of potentiometers R103 through R105 (TRACK 1 through TRACK 3). Potentiometers R102 and R106 set the low and high voltage limits respectively. The LOW MODE potentiometer R107 and HIGH MODE potentiometer R108 are screwdriver adjustment controls, which permit the proper initial setting of the repeller voltage. A cam controlled by the RF OSC. knob automatically actuates MODE switch S101, thereby switching the repeller voltage from the 4-3/4 to the 2-3/4 mode.

### 3-8. Power Monitoring Circuit

The rf power monitor is used to calibrate the output

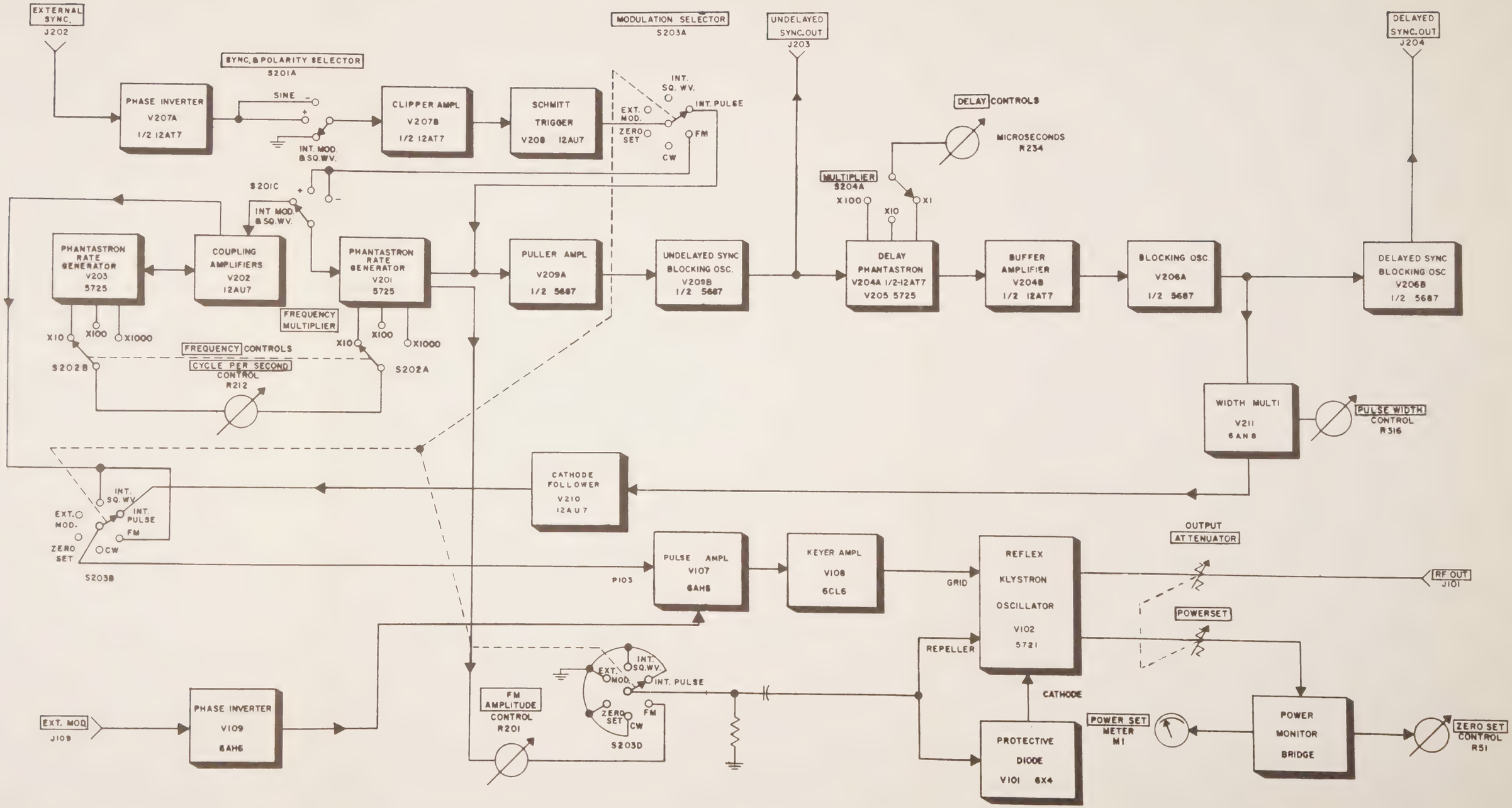



Figure 3-1. Signal Generator MSG-34, Block Diagram

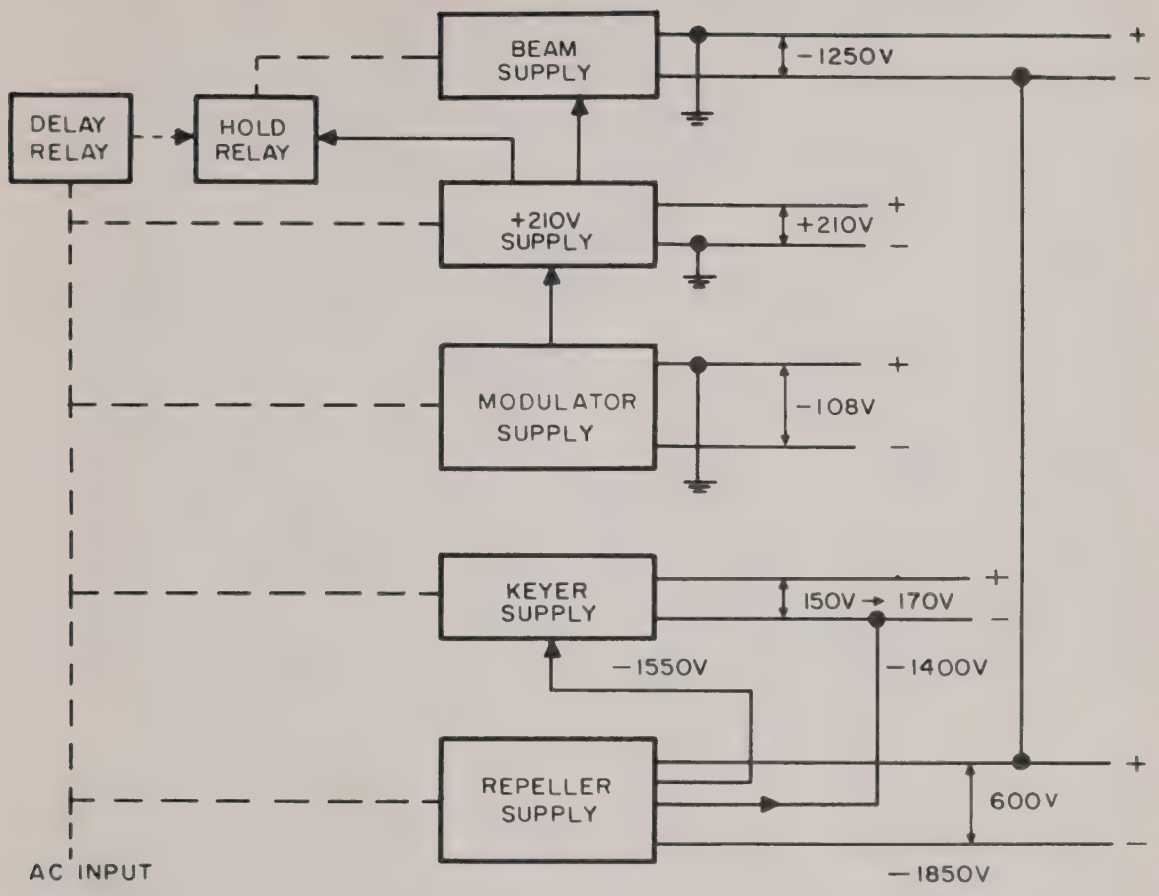



Figure 3-2. Power Supplies, Block Diagram

of the attenuator. The rf power monitoring circuit consists of a Wheatstone type bridge, which measures power by the use of a variable resistance element (thermistor) in a bridge circuit. A thermistor has a negative temperature coefficient of resistance; i.e., as the temperature increases, the resistance decreases, and vice versa. Changes of thermistor temperature, and hence resistance, are governed by three factors. These are: thermal changes in its environment; the current flowing through it; and absorbed rf power. By controlling the current required for balance, the bridge will determine the rf power by measuring the change in thermistor resistance caused by the applied rf power.

Two types of thermistors are used in the monitor, bead (RT101) and disc (RT102 and RT103). The bead thermistor, used for power measurement, has a small mass and is affected by all of the changes mentioned above. The disc thermistor, used in compensating networks, has a large mass; its resistance is relatively insensitive to the current flowing through it and is dependent, primarily, on the ambient temperature.

The basic bridge circuit is balanced (ZERO on meter) by adjusting the ZERO SET potentiometer R51 and the COARSE ADJ potentiometer R50. The COARSE ADJ potentiometer is factory adjusted to permit the ZERO SET control to cover the entire temperature operating range. Normally this potentiometer need not be adjusted. Adjustment is required if the meter goes beyond full scale deflection. For adjustment procedure of COARSE ADJ, see table 5-1. The bridge is so designed that for a given frequency the bead thermistor must be inserted into the cutoff waveguide so that one milliwatt of rf power will be indicated by the POWER SET mark on the meter. Movement of the bead thermistor is controlled by the POWER SET knob on the front panel.

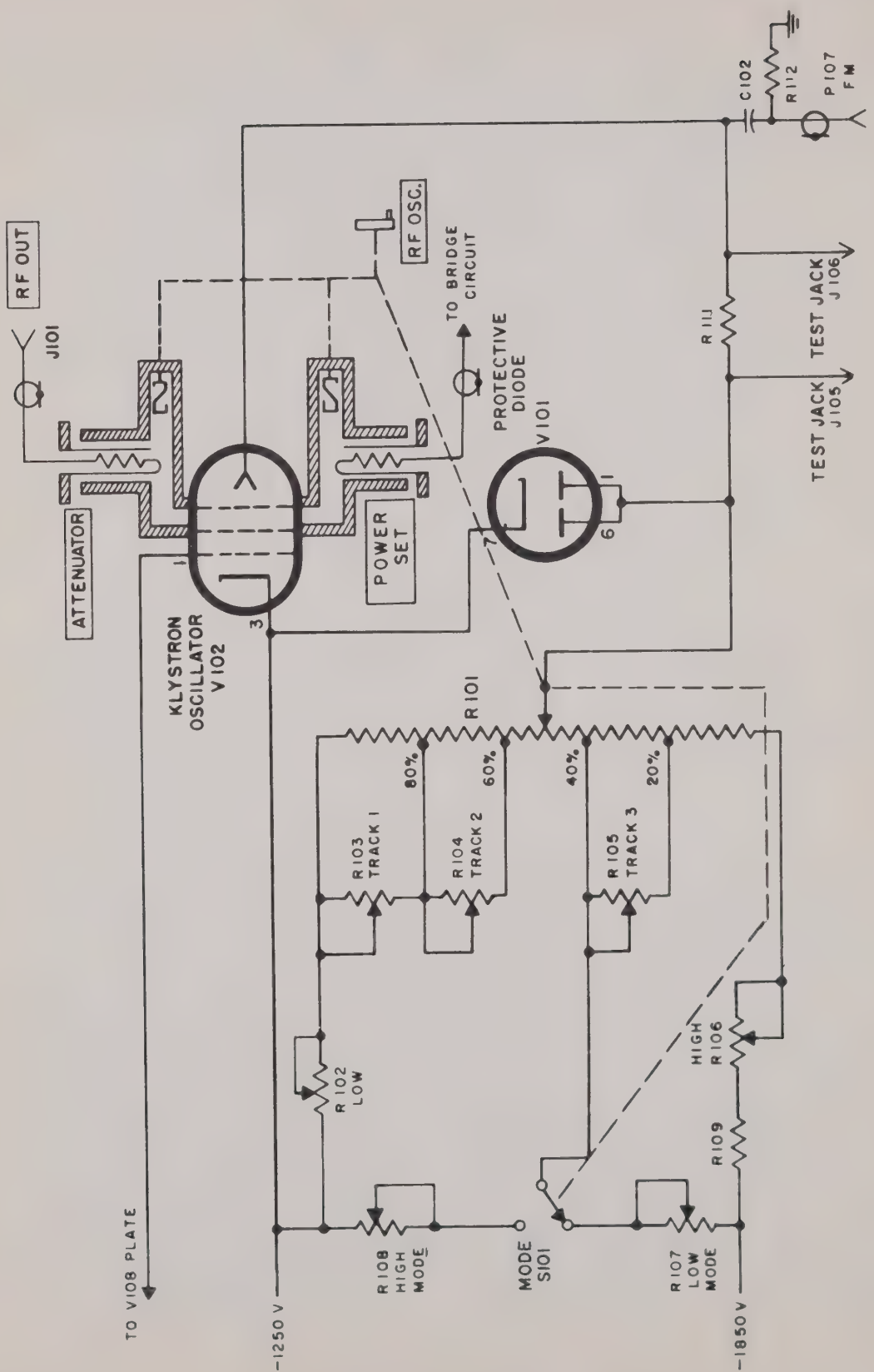



Figure 3-3. Klystron Oscillator, Simplified Schematic Diagram

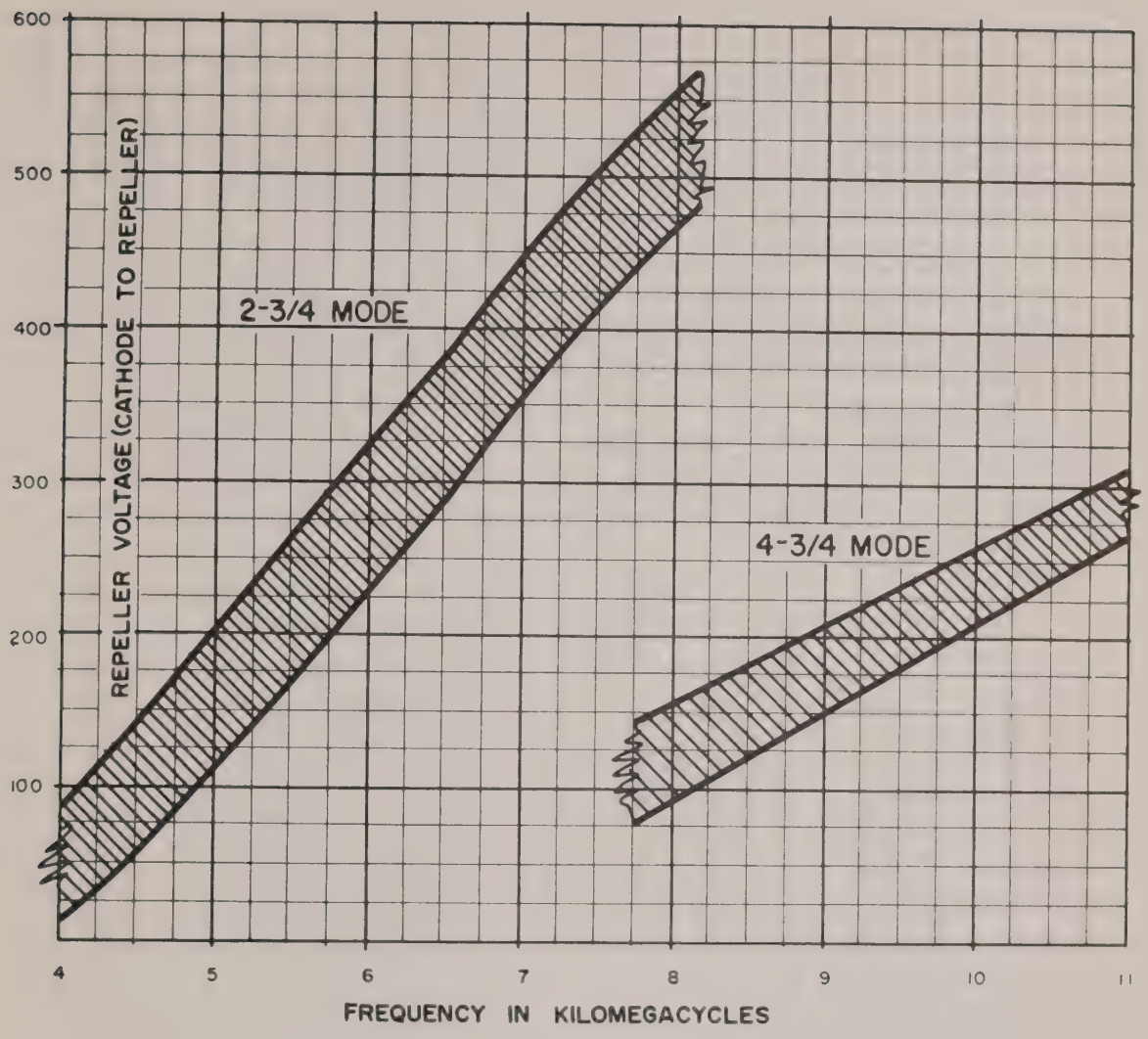



Figure 3-4. Repeller Voltage Characteristic Chart

### 3-9. Attenuator

The attenuator couples a known signal to the RF OUT receptacle. A piston attenuator assembly is inserted into the waveguide-beyond-cutoff tube. This assembly is controlled by the ATTENUATOR knob through a rack and pinion gear. Above the knob, a dial indicator affords direct reading of the output in decibels below a one-milliwatt reference level and microvolts as marked, with a 50-ohm resistive load. The setting of the one-milliwatt reference level is a function of the power monitoring circuit discussed in the preceding paragraph.

### 3-10. Modulated Operation

In modulated operation, the klystron keying voltage may be supplied by an external pulse or by the modulator section, which may be triggered by an internal pulse or sawtooth, or by an external pulse. Delayed and undelayed sync pulses are available when the modulator supplies the keying voltage.

### 3-11. Internal Modulation

The signal generator functions as a self-triggered

self-synchronous pulse generator when SYNC & POLARITY SELECTOR S201 is in INT. MOD. SQ. WV. position and MODULATION SELECTOR S203 is in INT. PULSE position. The keying voltage is then supplied by the keyer circuit, which is triggered by the modulator.

### 3-12. Rate Generator Circuit V201, V202, and V203

a. Two identical free-running, screen-coupled phantastron circuits, connected back-to-back with coupling amplifiers, supply the necessary triggers for internal pulse and square wave modulation, plus the sawtooth voltage for frequency modulation, at a controlled repetition rate. The repetition rate is determined by the value of capacitance switched into the plate-to-grid circuit of the respective phantastron circuit by means of sections A and B of FREQUENCY MULTIPLIER S202, and by the value of resistance set by FREQUENCY CYCLES PER SECOND control R212, in conjunction with LOW FREQ ADJ R217 and SQ WV SYMMETRY ADJ R211, in the control grid circuit of tubes V201 and V203. Table 3-1 is a convenient tabulation of the different repetition frequency ranges.

TABLE 3-1. SETTINGS FOR REPETITION FREQUENCY RANGES.

| FREQUENCY CYCLE PER SECOND CONTROL | FREQUENCY MULTIPLIER CONTROL | REPETITION FREQUENCY RANGE |
|---|---|---|
| 1 - 10 | X10 | 10-100 |
| 1 - 10 | X100 | 100-1,000 |
| 1 - 10 | X1,000 | 1,000-10,000 |

b. The LOW FREQ ADJ R217 is an internal adjustment which is used to set the low pulse frequency limit. SQ WV SYMMETRY ADJ R211 is an internal adjustment which is used to make the square wave symmetrical. In pulse operation, the screen waveshape of phantastron V201 is differentiated by an RC network (C204 and the parallel combination of R204 and R281) and fed to puller amplifier V209A.

c. In SQ. WV. operation phantastron V201 acts as described above, and the signal from coupling amplifier V202B is fed through modulation selector switch S302B to pulse amplifier V107. In FM operation, the sawtooth output from the plate of phantastron generator V201 is controlled by the FM AMPLITUDE control R201. The controlled sawtooth is applied directly to the klystron repeller.

### 3-13. Undelayed Sync Blocking Oscillator V209

Puller amplifier (V209A) receives the differentiated screen waveshape from phantastron V201 and couples the signal to blocking oscillator V209B. A triggered blocking oscillator circuit is used to provide sharp pulses in either INT. PULSE or SQ. WV. position of the MODULATION SELECTOR switch. Triggers of 0.25 microsecond in width, and better than 0.1 microsecond in rise time, with a minimum amplitude of 15 volts positive, are available at the UNDELAYED SYNC OUT receptacle on the front panel. The undelayed sync pulse leads the leading edge of the modulated rf test signal by an amount indicated by the delay controls. In pulse modulation, triggers from the cathode of V209B are fed to the suppressor grid of delay phantastron V205 through diode CR211, where the negative peaks are clipped.

### 3-14. Delay Phantastron V205

a. The trigger at the cathode of V209B is coupled to the suppressor of the delay phantastron, which is a screen-coupled phantastron circuit with a speedup cathode follower. The positive trigger applied to the suppressor allows the plate to draw current. The plate voltage drops, the grid voltage drops proportionally, the cathode current falls, and the screen voltage rises. This causes the suppressor voltage to rise, because it is obtained from the same bleeder as the screen potential. The plate potential then runs down linearly as in the Miller circuit. The end of this period comes when the control grid goes positive again, resulting in an increase of cathode current, in suppressor cutoff, and heavy screen current. The delay is adjusted by varying the RC time constant and by varying the plate-clamping potential. DELAY MULTIPLIER selector S204A switches different value capacitors into the plate-to-grid circuit, which change the delay range. MIN DELAY ADJ R233 is used to set the minimum delay of the phantastron. DELAY MICROSECONDS potentiometer R234 is the fine delay control on the front panel.

b. The delayed pulse is taken off the suppressor of V205, fed to voltage divider R229 and R230 which provide bias for V204B, and then is applied to the grid of buffer amplifier V204B. The buffer amplifier isolates, amplifies, inverts and differentiates the output signal. The positive pulse from the buffer amplifier is coupled to blocking oscillator V206A, which drives the width multivibrator V211.

### 3-15. Delayed Sync Blocking Oscillator V206B

Delayed Sync Blocking Oscillator V206B is a triggered blocking oscillator circuit. Two outputs are obtained from V206B: a sharp positive pulse from the cathode, and a negative pulse from the plate. Both outputs have a repetition rate identical to the delay phantastron output, and have a delay time which is determined by the delay phantastron output. The positive pulse output is fed to receptacle J204 on the front panel, DELAYED SYNC. OUT. This pulse is coincident with the leading edge of the modulated pulse output, or leads by maximum .1 usec.

### 3-16. Width Multivibrator V211

The width circuit is a monostable multivibrator using a triode-pentode. The repetition rate is controlled by the repetition rate of the positive driving pulse from the cathode of blocking oscillator V206A. The effective width of the multivibrator is adjustable between .2 and 10 microseconds by the fine PULSE WIDTH control on the front panel. MIN WIDTH ADJ R315 sets the minimum pulse width.

### 3-17. Cathode Follower V210

The pulsed output of multivibrator V211 is fed to cathode follower V210 which acts in the conventional manner as an impedance-lowering device. Its high input impedance and very low output impedance make it particularly suitable for coupling between the pulse-generating and pulse-amplifying circuits where shunt capacitance could otherwise cause objectionable effects. V210 is a dual-triode with both halves connected in parallel for maximum power-handling capacity. Power amplification is obtained because the ratio of input impedance to output impedance is very large. The low-impedance output is fed to the INT. PULSE position of modulation selector switch S302B.

### 3-18. Pulse Amp. V107 & Keyer Amp. V108

Pulse amplifier V107 amplifies the output of cathode follower V210 during INT. PULSE operation, and amplifies the output of coupling amplifiers V202 during INT. SQ. WV. and FM operation. During external modulation it amplifies pulses from an external source. The external signals are applied to V107 via EXT. MOD. receptacle J109, phase inverter V109, SYNC & POLARITY SELECTOR S201D, and relays K101 and K102. In INT. PULSE, INT. SQ. WV. and FM operation, the pulse taken off the plate of V107 is coupled by C115 through K102 to the control grid of keyer amplifier V108. V108 is thus driven to cut-off. During this cut-off period, klystron V102 oscillates. The klystron cathode-to-grid voltage is determined by the setting of BEAM CURRENT ADJ R127 in the keyer supply, (which is referenced to -1400 volts), while V108 is cut off. In CW operation the control grid of V108 is brought to a voltage divider consisting of R147 and R143. Negative 50 volts (with reference to the -1400 volt line) is supplied, which cuts off the keyer amplifier tube and allows the klystron to oscillate. The peak power output in pulse operation is the same as that for CW operation.

### 3-19. External Sync Circuit

Provision is made for synchronizing the modulation voltage with an externally applied sine wave, or a positive or negative pulse signal, through EXTERNAL SYNC. receptacle J202. After amplification and polarity inversion by phase inverter V207A, the resultant pulse is fed to the control grid of clipper amplifier V207B, which then couples the signal to the Schmitt trigger circuit V208. The Schmitt trigger circuit has a constant peak value output (a flat-topped pulse) which is independent of the shape of the input voltage waveform. The duration of the positive portion of the square wave output corresponds to the period that the input waveform exceeds a specific voltage.

### 3-20. External Sync Modulation

Operation of the signal generator with external sync modulation is identical to internal modulation operation, except that SYNC. & POLARITY SELECTOR S201 is set to correspond with the polarity of the applied external signal. The external pulse applied at the EXTERNAL SYNC. receptacle J202, is used to trigger the rate generator when MODULATION SELECTOR S203A is in either the FM or INT. PULSE position.

### 3-21. FM Modulation

When MODULATION SELECTOR S203 is in FM position, a sawtooth voltage from the plate of rate generator V201 is fed through FM connectors J107 and P107 to C102. This capacitor feeds the voltage directly to the repeller electrode of the klystron oscillator tube. The output of the oscillator is then frequency-modulated at a deviation dependent upon the setting of FM AMPLITUDE control R201.

### 3-22. Protective Relays

When switch S1 is closed, 115 vac is applied to all circuits except the Beam Power Supply. In order to protect the klystron tube, thermal time Delay Relay K1, is energized through the normally closed contacts (7 and 2) of hold relay, K2. After a delay of 60 seconds, contacts 3 and 8 of relay K1 close. DC from the +210 volt supply passes through the coil of hold relay K2, the normally open circuit contacts (3 and 4) close and apply ac to the beam supply, and simultaneously de-energize delay relay K1.

### 3-23. Functional Operation of the Mechanical Components

ELECTRO-MECHANICAL SCHEMATIC (See figure 3-5) illustrates ganging of thermistor and attenuator probes. The tuning plunger does not mechanically contact the inner and outer conductors. Broadband effective "short-circuit" is achieved by making the choke approximately a 1/4 wavelength at mid-band, keeping the gap between the choke and inner and outer conductors to a practical minimum and using teflon as a bearing surface. There are two required conditions for proper oscillation. The plunger must be at a predetermined position within the coaxial line and the repeller voltage must be at some proper value within a predetermined repeller mode. The plunger is driven by a cam which corrects for the non-linearity of plunger position with frequency. With a fixed cam the variation of tuning curve from klystron to klystron would not permit better than an approximately five percent frequency dial accuracy. Frequency dial accuracy, with tube changes, is improved to one percent by making the cam adjustable through five variable eccentric points. The second requirement for

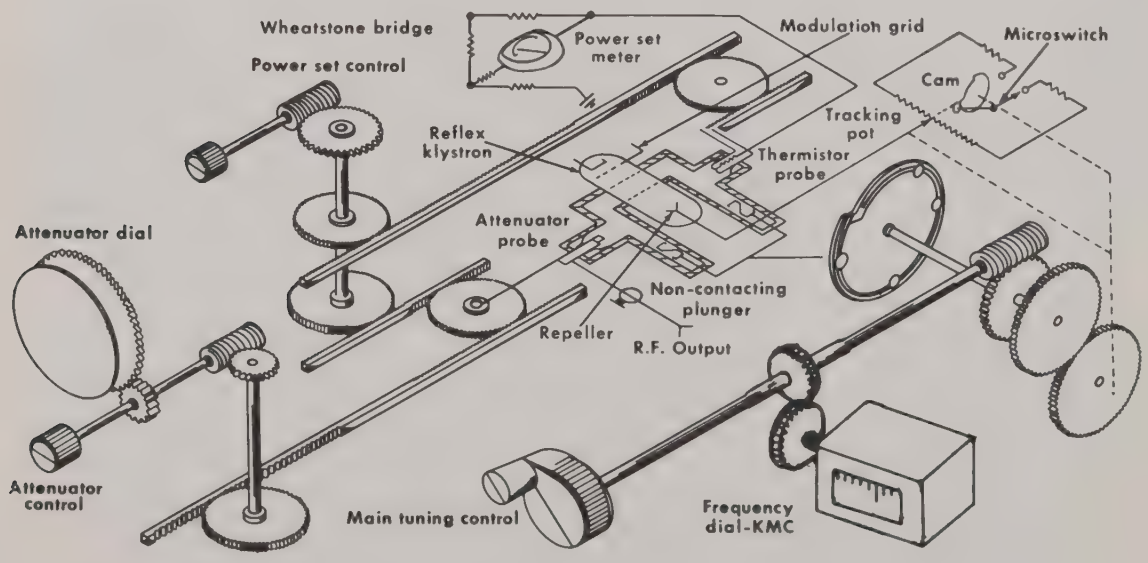



Figure 3-5. Signal Generator MSG-34, Electro-Mechanical Schematic Diagram

oscillation is obtained by mechanically ganging a tapped potentiometer to the camshaft that automatically tracks and switches repeller modes. The cavity has two identical waveguide-beyond-cutoff outputs; the guide for the thermistor probe, which is one arm of a Wheatstone bridge, and that for the output attenuator. Adjustment of the power set control moves both the thermistor and attenuator probes in a 1:1 ratio. The output attenuator control varies the attenuator probe independently of the thermistor probe. To calibrate the output attenuator, the Wheatstone bridge is balanced with the rf oscillator off. With the oscillator on, the power set is adjusted so that the bridge meter reads at mid-scale. Actual power output can now be read directly from the attenuator dial. If the rf oscillator is changed to any other frequency, the same calibrated rf output is maintained simply by readjusting the power set so that the meter reads mid-scale. Manual adjustment of frequency is made with the RF OSC. control.

# SECTION 4
# MAINTENANCE

## 4-1. General

An understanding of the theory of operation, as described in Section 3, will prove helpful in locating and correcting any defect which may occur. The mechanical drive systems are designed for life-of-equipment operation, and should not be tampered with unless breakdown occurs. Unnecessary adjustments of the klystron oscillator and calibrated modulator circuit should not be made, since these changes may result in loss of accuracy.

## 4-2. Access to the Equipment

a. To remove the signal generator from its case, set the unit face down. Loosen the camlocks located at each corner of the rear dust cover. Slide the case upward.

b. To gain access to components located on the sub-chassis, proceed as follows:

**NOTE**

When sliding unit or sub-assemblies out of the frame ensure that cables are free of components and chassis.

1) Remove the four machine screws, which secure the modulator front panel to the main frame. Lift the sub-chassis up slightly and pull partially out of the main frame. Remove connectors P2, P103, and P107 from their sockets, to completely disengage the sub-chassis. Pull the modulator sub-chassis completely out of the main frame for inspection and testing.

2) RF and Keyer Chassis. Remove the four machine screws, located on the front panel of the rf and keyer chassis, and the two machine screws, located at the rear to hold the P1 bracket in place. These screws secure the rf and keyer chassis to the main frame. Remove connectors P1, P103, and P107 from their sockets, to completely disengage the rf and keyer chassis. Withdraw this chassis from the main frame for inspection and testing. Put both the main frame and the rf and keyer chassis back-to-back, and reconnect plugs.

## 4-3. Preliminary Inspection Procedures

Preliminary inspection comprises a series of operations performed on the signal generator, while it is turned off, to correct conditions which might lead to a breakdown. These breakdowns may be caused by accumulation of dust and dirt on parts, or by loose connections and fittings. Table 4-1 lists the preliminary inspection procedure.

**WARNING**

OPERATION OF THIS EQUIPMENT INVOLVES THE USE OF HIGH VOLTAGES WHICH ARE DANGEROUS TO LIFE. UNLESS ABSOLUTELY NECESSARY, DO NOT SERVICE OR TEST EQUIPMENT WHEN OPERATING POWER IS APPLIED. USE EXTREME CAUTION IN MAKING ALL VOLTAGE CHECKS. REMOVE POWER AND DISCHARGE CAPACITORS BEFORE TOUCHING THEM. DO NOT TOUCH VACUUM TUBES UNTIL THEY HAVE COOLED, OR SEVERE BURNS MAY RESULT.

TABLE 4-1. PRELIMINARY INSPECTION PROCEDURE

| STEP | WHAT TO INSPECT | DEFECTS | REMEDIES | PRECAUTIONS |
|---|---|---|---|---|
| 1 | Ac line cord, video cable and rf cable. | Kinks in the cable, cuts, deteriorations, and fraying of the rubber insulation. | Replace the cable, if necessary. | Make sure that proper type and length of cabling is used. |
| | | Loose connectors. | Tighten or resolder connections, or replace cable. | |
| | | Dirt, oil, grease, corrosion. | Clean with lint-free cloth moistened with carbon tetrachloride; then wipe dry. | CAUTION: Repeated contact of carbon tetrachloride with skin, or prolonged breathing of the fumes, is dangerous. Make sure adequate ventilation is provided. |

TABLE 4-1. PRELIMINARY INSPECTION PROCEDURE (Continued)

| STEP | WHAT TO INSPECT | DEFECTS | REMEDIES | PRECAUTIONS |
|---|---|---|---|---|
| 2 | Power Monitor Meter. | Bent indicator, cracked or broken glass. | Replace the meter, if necessary. | |
| 3 | Knobs, screws, connectors, handles. | Looseness. | Tighten. | Tighten carefully, so as not to damage screws on equipment. |
| 4 | Switches. | Inability to change positions, or evidence of slipping. | Replace all defective switches. | |
| 5 | Rear of panel and chassis. | Dirt, corrosion, moisture, rust. | Remove loose dirt and dust with a brush or low air pressure. Remove dirt and grease on the chassis or panel with a brush or cloth dipped in carbon tetrachloride. | |
| 6 | Mounting screws and clamps. | Looseness. | Tighten. | Do not touch slotted shafts of variable resistors. |
| 7 | Solder joints. | Loose or cold soldered joints; corroded joints. | Resolder; clean and resolder. | |
| 8 | Capacitors. | Leaks, bulges, signs of discoloration. | Replace capacitor. | |
| 9 | Pilot lights. | Jewels cracked, broken or missing; does not operate. | See that all lamps are operating. Replace burned out lamps. Replace missing, broken or cracked jewels. | |
| 10 | Tubes, except reflex klystron. | Poor seating. | Press tubes firmly into sockets. | Never work on tubes immediately after shutdown. Severe burns may result. Do not jiggle tubes, or partially withdraw them from sockets. Such movements tend to weaken tube pins and to spread the contacts in the socket. Do not check the reflex klystron tube. |
| 11 | Tube shields except for reflex klystron. | Looseness. Missing shields. | Press into position. Replace. | |
| 12 | Tube sockets. | Looseness.<br><br>Cracks, chips. | Tighten mounting screws.<br><br>Replace socket, if necessary. | |

TABLE 4-1. PRELIMINARY INSPECTION PROCEDURE (Continued)

| STEP | WHAT TO INSPECT | DEFECTS | REMEDIES | PRECAUTIONS |
|---|---|---|---|---|
| 13 | Oscillator drive. | Catching or jamming when the RF OSC. knob is rotated. Dust or dirt, or foreign matter in oscillator gear box or on oscillator drive shaft. | Clean. Remove all foreign matter. | CAUTION: Do not drive oscillator in any way other than by its control knob. Do not interfere in any way with the operation of the gear mechanism while the control is being tuned. Never use force. |
| | | Bent or broken teeth on gears. | Return to manufacturer or obtain replacement. | |
| 14 | Thermistor and Attenuator Drive Assembly. | Catching or jamming when either the ATTENUATOR or POWER SET control knobs are turned. Dust, dirt, or foreign matter. | Remove dirt and foreign matter with a brush or lint-free cloth dipped in carbon tetrachloride. | CAUTION: Refer to caution for Oscillator Drive (step 13). |
| 15 | Air filter needs cleaning and re-oiling. | Appears dirty or clogged. | Clean with carbon tetrachloride. Dip into a mixture of 1 part SAE No. 30 oil and 3 parts thinner. Shake out and wipe fan blades. | |

## 4-4. Trouble Shooting

Table 4-2 lists the trouble shooting procedure for localizing a defect to a particular circuit. Figures 4-1 and 4-2 show the right and left view of the complete unit. Figure 4-3 is a top view of the Modulator Power Supply chassis showing the location of components and figure 4-4 is a view showing the components located on the underside of the chassis. Figure 4-5 is the component layout of the modulator section of the equipment for ease in locating components. Figures 4-6 and 4-7 are photographs of the top and bottom of the Repeller and Beam chassis, respectively, showing the location of components. Figure 4-8 is an overall view of the RF and Keyer Supply showing adjustments, components, and test jacks.

Do not disturb any set adjustments unless the trouble is definitely caused by a chassis adjustment control.

**NOTE**

As the first step in any trouble shooting, check the power supplies, and relays K101 and K102, for proper operation. It is advisable to follow Table 4-2, the trouble shooting chart, step by step during trouble shooting the unit.

TABLE 4-2. TROUBLE SHOOTING

| STEP | SYMPTOM | PROBABLE CAUSE | POSSIBLE REMEDY |
|---|---|---|---|
| 1 | Instrument not operating. | Blown line fuses. | Replace. |
| 2 | Low operating voltages | 115-230V switch in wrong position. | Place in proper position. |
| 3 | No repeller voltage -600V. | Check V7 and V8. | Replace if defective. |
| 4 | Repeller voltage high, no regulation. | Check V9. | Replace if defective. |
| 5 | No beam vo'tage -1250V. | Check V1, V2, V3, K1 and K2. | Replace if defective. |

TABLE 4-2. TROUBLE SHOOTING (Continued)

| STEP | SYMPTOM | PROBABLE CAUSE | POSSIBLE REMEDY |
|---|---|---|---|
| 6 | Beam voltage high, no regulation. | Check V4. | Replace if defective. |
| 7 | No +210V. | Check V17 and V18. | Replace if defective. |
| 8 | +210 volts high, no regulation. | Check V19. | Replace if defective. |
| 9 | No -108 volts. | Check V13 and V14. | Replace if defective. |
| 10 | -108 volts high. | Check V15. | Replace if defective. |
| 11 | Power set meter cannot be zeroed when MODULATION SELECTOR switch is in ZERO SET position. | P1 not connected<br>J1 defective.<br>RT101 defective.<br>M1 defective.<br>R51 defective.<br>R50 defective or misadjusted. | Connect.<br>Replace.<br>Replace.<br>Replace.<br>Replace.<br>Replace or readjust COARSE ADJ potentiometer R50. |
| 12 | No power indication on power set meter with MODULATION SELECTOR switch in CW position. | BEAM CURRENT ADJ R127 defective or misaligned.<br><br>Defective klystron V102. | Readjust or replace R127. See Table 5-1.<br><br>NOTE: Check all other trouble symptoms before removing klystron tube from cavity. |
| 13 | MODULATION SELECTOR switch in CW position; some indication at various points across the band; intermittent power. | Check R127 as in step 12.<br>Misalignment of repeller tracking system.<br>Weak klystron tube V102. | Check. Refer to paragraph 5-2d.<br><br>Replace. Refer to paragraph 4-7. |
| 14 | No rf power output at J101 RF OUT receptacle; power set readings are available across the band. | Check ATTENUATOR probe. | Replace. |
| 15 | No output when MODULATION SELECTOR switch is in PULSE, SQ. WV. or FM positions. | Check +210V supply and -108V supply. | Refer to steps 7, 8, 9, and 10. |
| | In the following modulation trouble shooting conditions, it is assumed that the oscillator is operating satisfactorily in CW. If not, see the above trouble shooting procedure. | | |
| 16 | (a) When MODULATION SELECTOR switch is in FM position and SYNC. & POLARITY switch in INT. MOD. SQ. WV. position, no rf FM output is available. | Check V201, V202, V203, and FM AMPLITUDE control R201.<br>Check J107 for sawtooth output. | Replace defective component. |

TABLE 4-2. TROUBLE SHOOTING (Continued)

| STEP | SYMPTOM | PROBABLE CAUSE | POSSIBLE REMEDY |
|---|---|---|---|
| 16 | (b) No rf FM output available when using external sync. | V207 and/or V208 defective. Check CR208, also items mentioned in part (a). | Replace defective part. |
| 17 | (a) No rf pulse available when MODULATION SELECTOR switch is in INT. PULSE and SYNC. & POLARITY SELECTOR is in INT. MOD. SQ. WV. position. | Check all tubes in modulator, except V207 and V208. | Replace where defective. (See theory and block diagram.) |
| | (b) No rf pulse output available when using external sync. | Check as in part (a) and include V207, V208 and R238. | Readjust R238 if necessary (for adjustment see paragraph 5-7). |
| 18 | Unable to vary pulse width when MODULATION SELECTOR switch is in INT. PULSE position. | Check V211, R315 and R316. | Readjust R315 and/or R309, or replace defective part. See paragraphs 5-8 and 5-9. |
| 19 | (a) No rf square wave or fm available when MODULATION SELECTOR is in INT. SQ. WV. and SYNC. & POLARITY SELECTOR is in INT. MOD. SQ. WV. position. | See step 17. Check input square wave at J103. | (See theory of operation and block diagram). |
| | (b) Poor symmetry in SQ. WV. operation. | R211 misaligned. | Readjust R211 or replace if defective. See paragraph 5-6. |
| 20 | Cannot externally modulate the klystron with either + or - signal. | Check V109, V108 and V107. | Replace where defective. |
| 21 | PRF range cannot be covered in FM, INT. PULSE or INT. SQ. WV. operation. | Check R212 and R217. | See adjustment procedure for R217 (paragraph 5-5). |
| 22 | DELAY range cannot be obtained in internal and external sync. | Check R234 and R233. | See adjustment procedure for R233 (paragraph 5-7). |
| 23 | No UNDELAYED SYNC pulse in internal operation. | Check V201, V202 and V203. | Replace where defective. |
| 24 | No DELAYED SYNC pulse in internal operation. | Check V206, DL202, T201, J204. Check V205, V204 and all of the tubes in step 23. | Replace where defective. Replace where defective. |

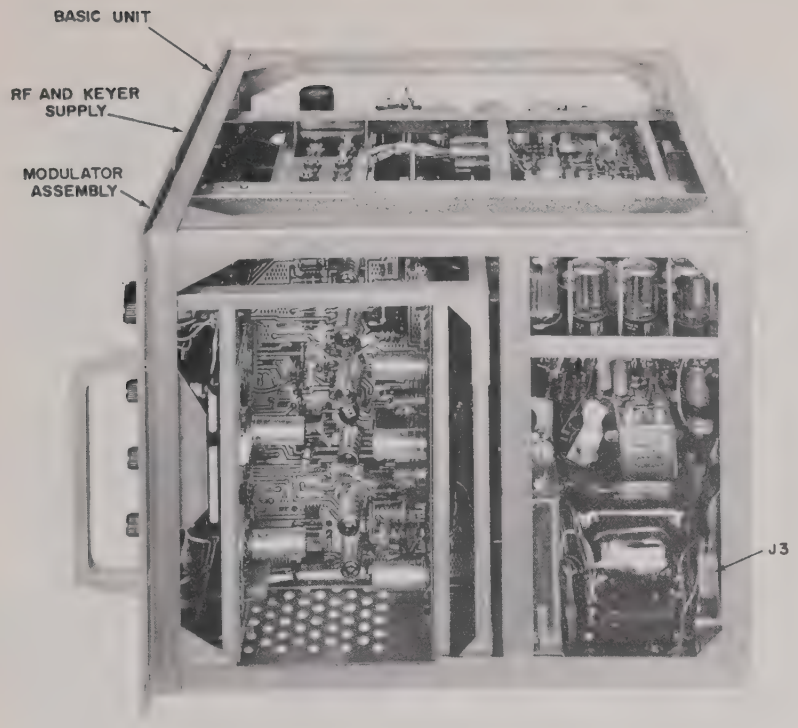



Figure 4-1. Signal Generator MSG-34, Side View Right

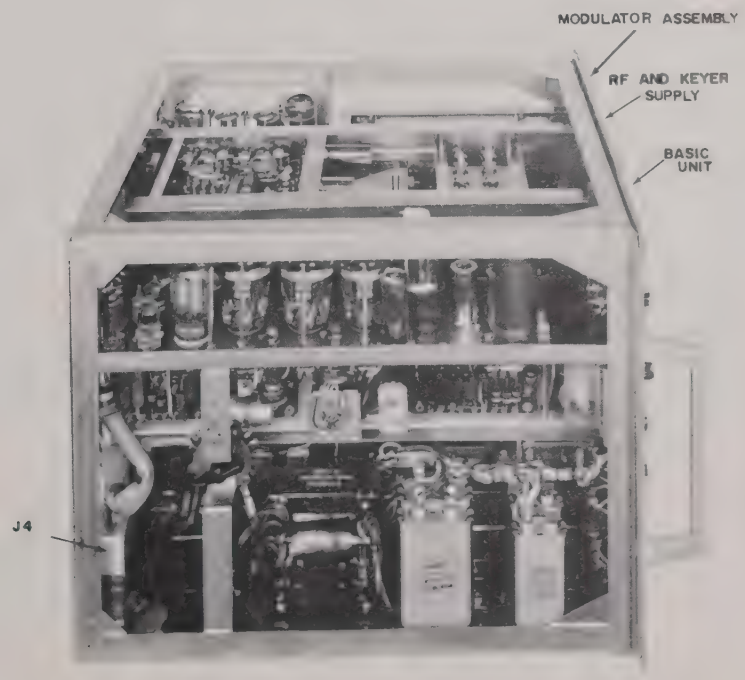



Figure 4-2. Signal Generator MSG-34, Side View Left

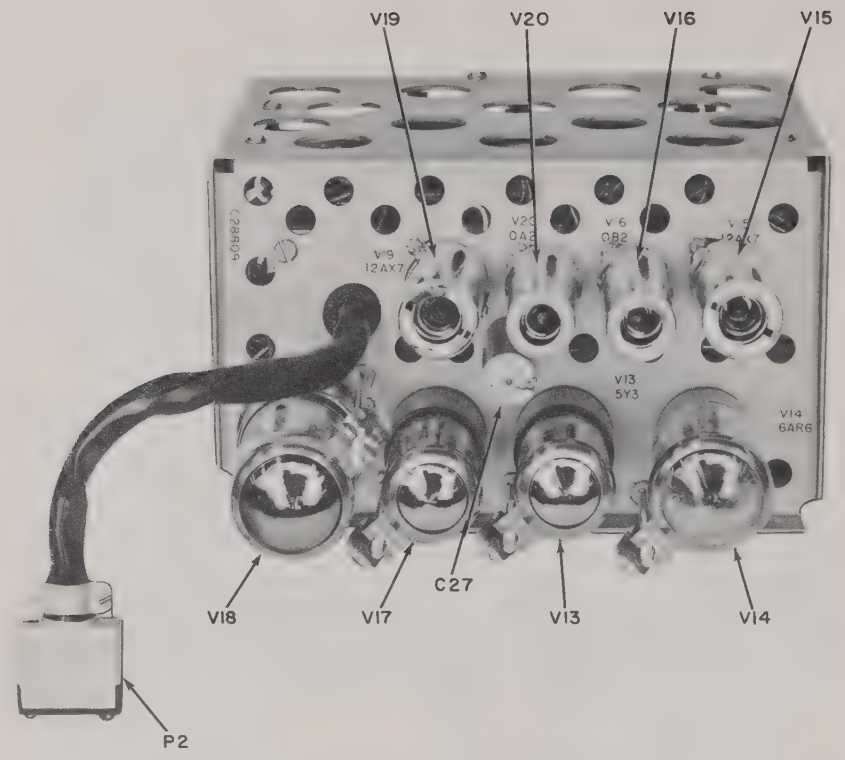



Figure 4-3. Modulator Power Supply, Top View

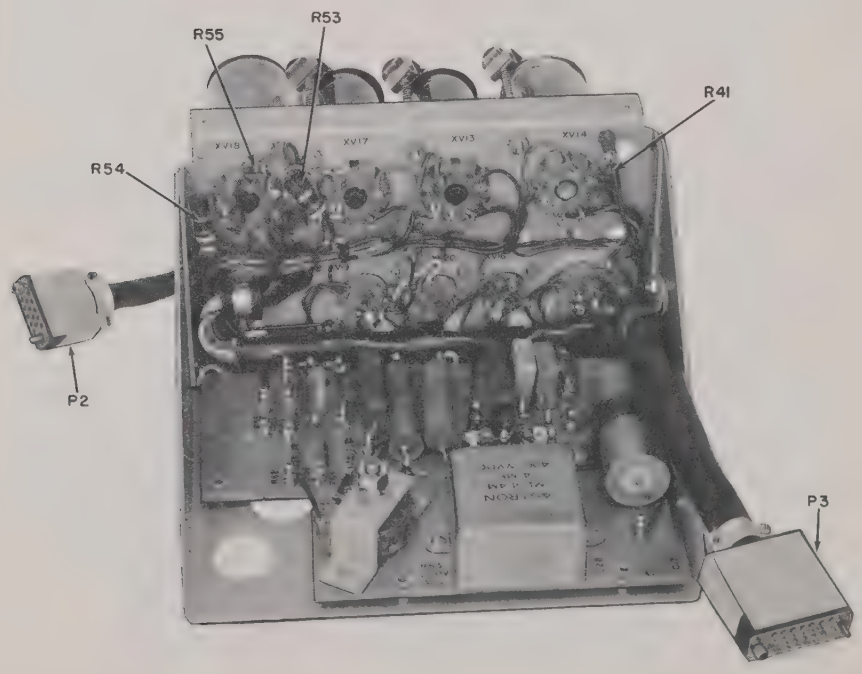



Figure 4-4. Modulator Power Supply, Bottom View

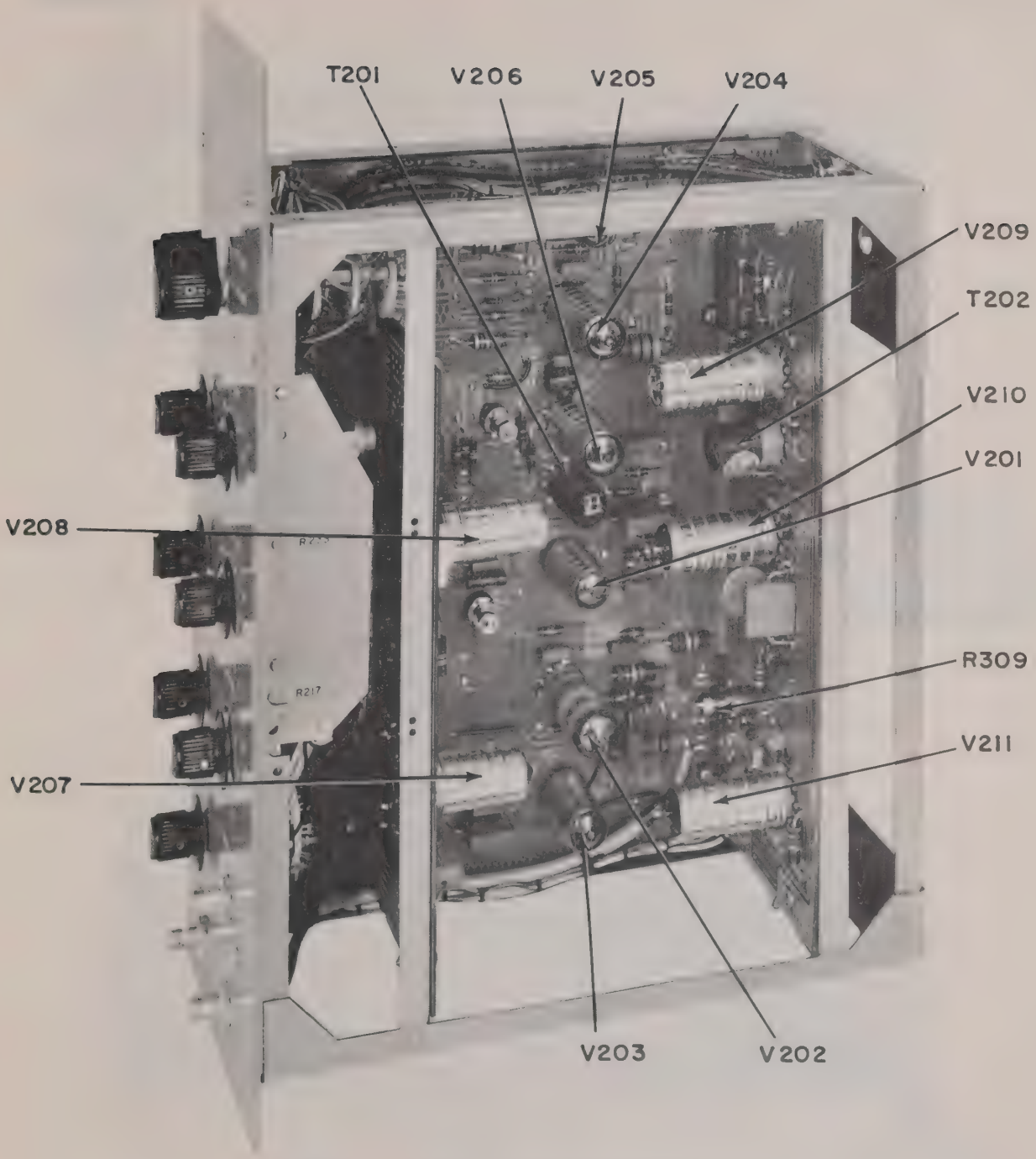



Figure 4-5. Modulator Assembly, Component Layout

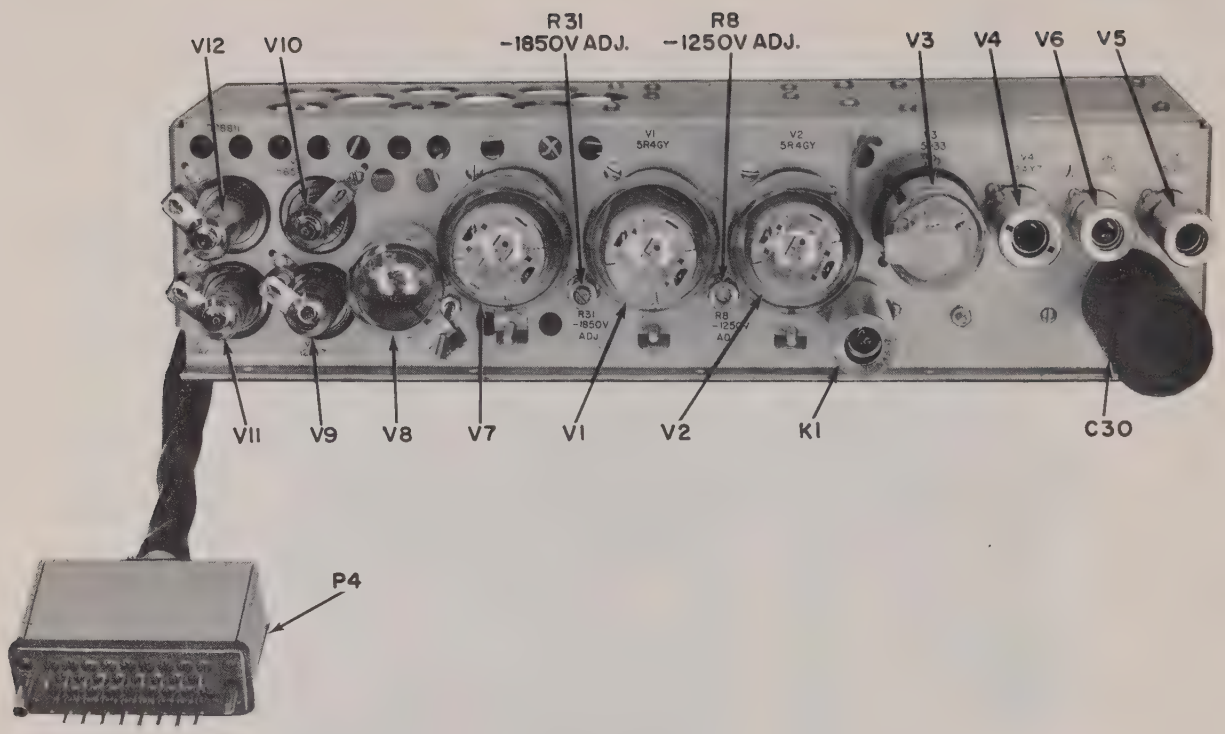



Figure 4-6. Repeller and Beam Chassis, Top View

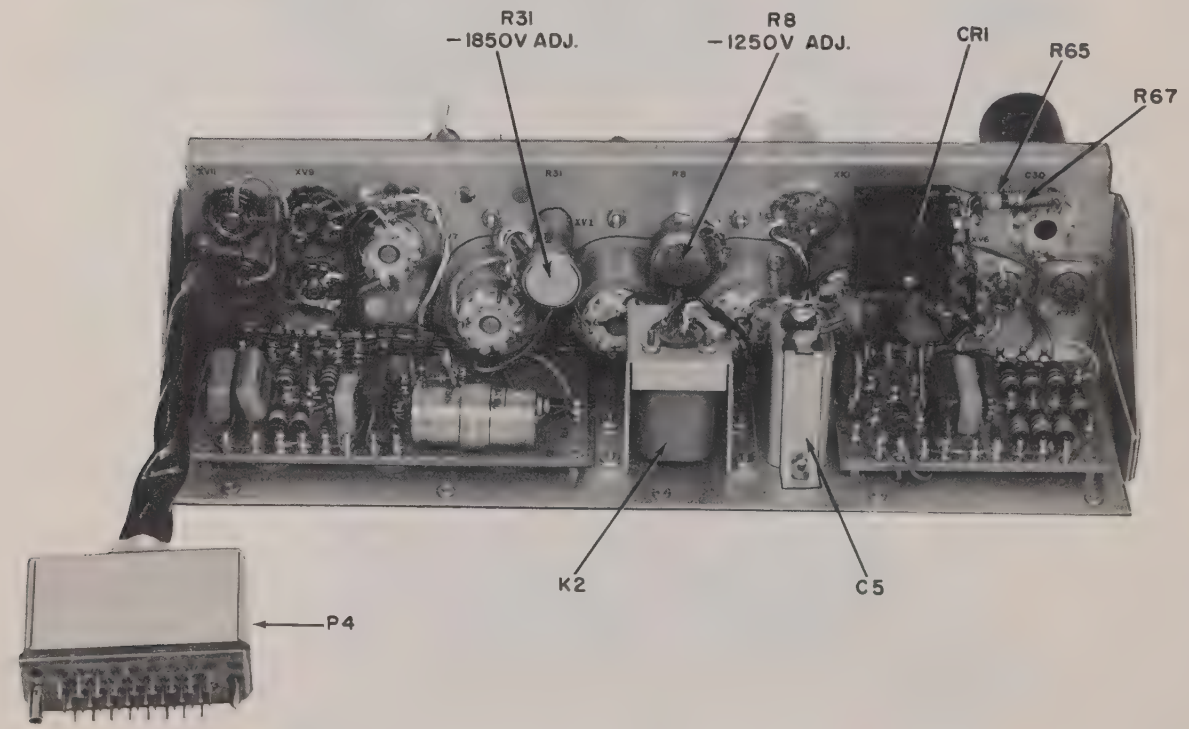



Figure 4-7. Repeller and Beam Chassis, Bottom View

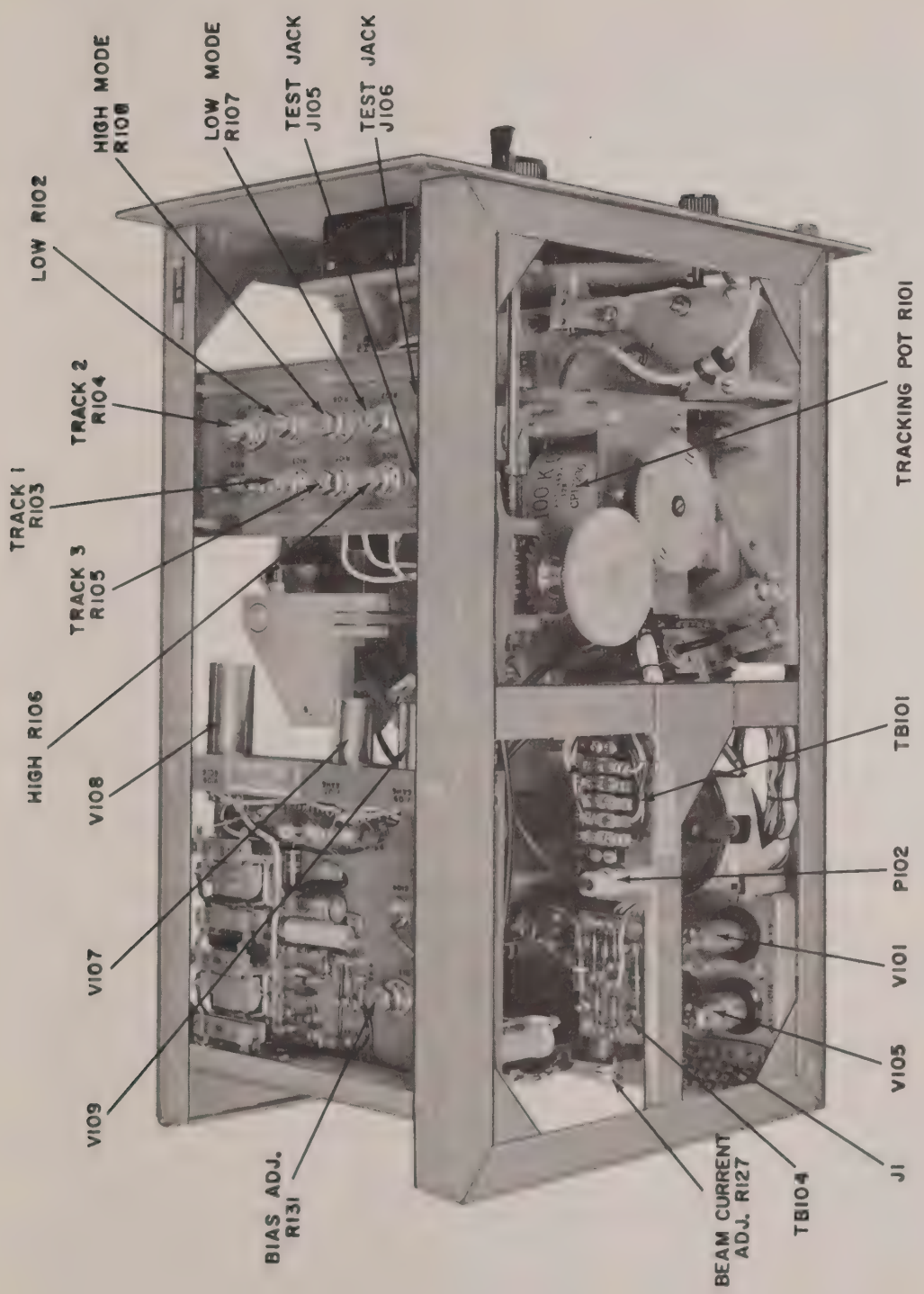



Figure 4-8. RF and Keyer Supply

## 4-5. Checking the DC Power Supplies

The dc voltages are obtained from five regulated power supplies; the beam supply, the repeller, the keyer, the modulator supply, and the +210V supply. Refer to section 3 for detailed discussion, and to figures 5-6 and 5-7 for the schematic diagrams. In the event a power supply does not give the normal indication called for in table 4-3 (Power Supply Voltages), refer to table 5-1 (Adjustments, Power Supplies) and to figures 4-3, 4-4, 4-6, 4-7, and 4-8 to locate the defective component in the supply.

TABLE 4-3. POWER SUPPLY VOLTAGES

| POWER SUPPLY | TEST POINTS FROM | TEST POINTS TO | VOLTS |
|---|---|---|---|
| Beam | C6 | Ground | -1250 |
| +210V | Pin 1, 5 of V20 | Ground | +210 |
| Repeller | Across C16 | | -600 |
| | C16 | Ground | -1850 |
| | Junction of R141 and R142 | Ground | -1550 |
| | Pin 7 of V107 | Ground | -1400 |
| Modulator | Pin 2, 4, 7 of V16 | Ground | -108 |
| Keyer | Across C106 | | 150 to 170 |

## 4-6. Checking Relays K101 and K102

The rotation of the MODULATION SELECTOR S203 to its various positions will cause relays K101 and K102 to energize. Table 4-4 indicates which relays will be energized at the various positions of the MODULATION SELECTOR. Check for dirty and bent contacts.

TABLE 4-4. RELAYS ENERGIZED

| MODULATION SELECTOR POSITION | RELAY K101 | RELAY K102 |
|---|---|---|
| EXT. MOD. | Energized | De-energized |
| INT. PULSE | De-energized | De-energized |
| INT. SQ. WV. | De-energized | De-energized |
| FM | De-energized | De-energized |
| CW | De-energized | Energized |
| ZERO SET | Energized | Energized |

## 4-7. Replacement of RF Klystron Oscillator Tube

**WARNING**

This equipment employs high voltages which are dangerous to life. Do NOT attempt to replace the reflex klystron oscillator tube unless the power cord is disconnected from power input receptacle J1, on the equipment front panel. For access to the equipment, refer to paragraph 4-2.

a. REMOVING THE KLYSTRON COVER and KLYSTRON TUBE.

To remove the klystron cover and tube from the rf cavity, proceed as directed below. (See figure 4-9).

(1) Loosen clamp strap around klystron cover.

(2) While holding cover in one hand, GENTLY pull the tube socket away from the base of the klystron.

(3) Use the spanner wrench supplied with the signal generator to loosen the klystron clamp (knurled silver-plated nut), which is threaded to the tuned cavity. Do not remove the knurled nut completely. A half turn counterclockwise is sufficient to release its locking action.

(4) Grasp the projecting end of the klystron tube, gently rotating it in a clockwise direction, while simultaneously withdrawing the tube from its spring-finger holder within the cavity.

(5) Carefully insert a replacement klystron tube, known to be in good operating condition, into the cavity, and press it all the way in, making sure the repeller cap makes firm contact with inner conductor.

(6) Use the spanner wrench to tighten the klystron clamp nut. Do not exert pressure.

b. REASSEMBLING THE KLYSTRON COVER.

To replace the tube shield, follow the directions below:

(1) Attach tube socket to the base of the klystron tube. Check that proper tube socket pins are engaged, since this miniature socket may easily be forced into an improper position, which will result in application of improper voltages to the klystron tube.

(2) Slide klystron cover over socket until klystron clamp nut is covered. Then tighten clamping strap to secure shield.

(3) Adjustment and alignment procedures must now be performed in this stage. Refer to paragraph 5-1 for BEAM CURRENT ADJ, to paragraph 5-2 for repeller tracking voltages, and to paragraph 5-4 for frequency dial calibration.

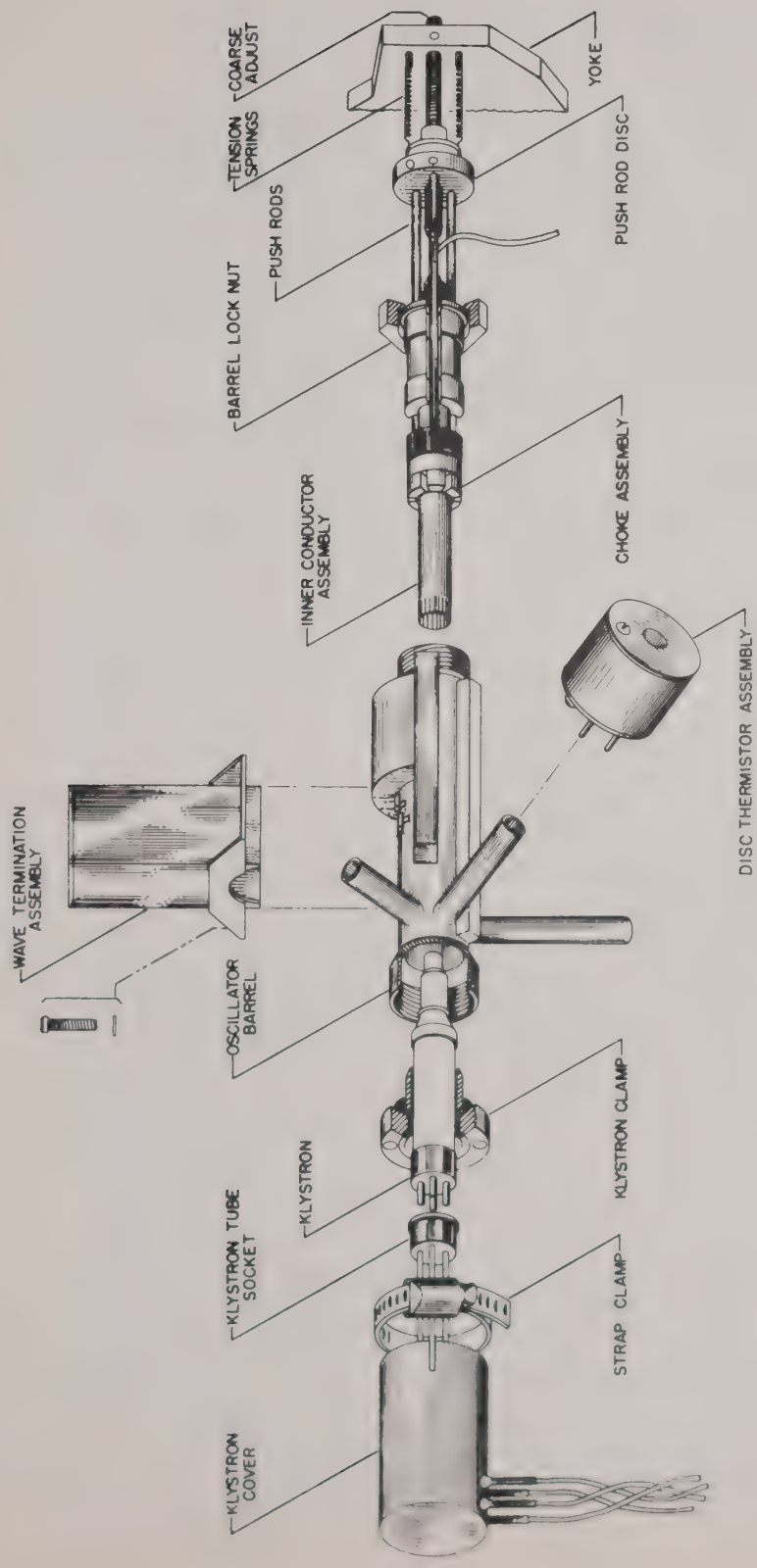



Figure 4-9. Oscillator Cavity, Exploded View

# SECTION 5
# ADJUSTMENT AND ALIGNMENT

**WARNING**

OPERATION OF THIS EQUIPMENT INVOLVES VOLTAGES WHICH ARE DANGEROUS TO HUMAN LIFE. REMOVE POWER AND GROUND CIRCUITS BEFORE TOUCHING THEM.

## 5-1. Power Supply Adjustments

The procedure for checking and adjusting the outputs of the various power supplies is given in table 5-1 (Adjustments, Power Supplies). See figures 4-3 through 4-8 for location of adjustment controls, components, and test points.

**CAUTION**

THE BEAM CURRENT ADJ R127, IN KEYER SUPPLY, IS FACTORY ADJUSTED AND SHOULD NOT BE TOUCHED EXCEPT TO CHANGE THE KLYSTRON TUBE OR DURING TROUBLE SHOOTING. MISALIGNMENT OF THIS CONTROL CAN RUIN THE KLYSTRON TUBE.

a. 115-230V SWITCHING SYSTEM.

The 115V-230V input switching system of the unit is normally factory set at 115 volts. If it is desired to use 230 volts as input to the unit, the internal input switching system must be set as follows:

(1) Remove the dust cover as described in paragraph 4-2.

(2) The 115-230V switch is a two position switch marked 115-230V. It is located on the basic unit.

(3) Simply place the switch in the position desired.

TABLE 5-1. ADJUSTMENTS, POWER SUPPLIES

| CIRCUIT | TEST POINTS | TEST EQUIPMENT | NORMAL INDICATION | ADJUSTMENT PROCEDURE |
|---|---|---|---|---|
| Beam Supply | 1 | DC voltmeter | -1250 volts | Adjust -1250v ADJ R8. If not normal, refer to paragraph 3-2 for theory. |
| +210V Supply | 2 | DC voltmeter | +210 volts | Adjust +210v ADJ R63. If not normal, refer to paragraph 3-6 for theory. |
| Repeller Supply | 3 | DC voltmeter | -1850 volts | Adjust -1850v ADJ R31. If not normal, refer to paragraph 3-3 for theory. |
| Keyer Supply | 4 | DC voltmeter | +1 volt across R5 with MODULATION SELECTOR switch in CW position. | Read CAUTION notice. Adjust BEAM CURRENT ADJ R127. If not normal, refer to paragraph 3-4 for theory. |
| Modulator Supply | 5 | DC voltmeter | -108 volts | There is no adjustment for this supply. Its normal output is 108 volts. It is possible, however, to misalign COARSE control R50 to lower the output. Refer to bridge circuit below and paragraph 3-5. |
| Bridge Circuit | None | None | Meter M1 can be set to ZERO with MODULATION SELECTOR switch in ZERO SET position. | Allow signal generator to remain off at least one hour. Turn set on and adjust ZERO SET control fully clockwise. Adjust COARSE ADJ R50 until meter goes beyond full scale deflection. Refer to paragraph 3-8 for theory. |

## 5-2. Repeller Voltage Tracking Procedure

a. GENERAL.

Due to variations in klystron tube characteristics, replacement of the tube will usually require readjustment of the repeller tracking voltages. The repeller voltage tracking procedure assumes that the unit was previously aligned and operating, but that the klystron was changed. The repeller voltages are first adjusted for proper mode trace on the oscilloscope in CW operation, and then in pulse-modulated output. The equipment needed to perform the above is listed in table 5-2.

b. TEST SETUP.

(1) Remove the rf chassis from the main frame as described in paragraph 4-2, and connect all plugs. Proceed with CAUTION. Set up the equipment while operating power is disconnected. See figure 5-1 for the test setup. The modulator phase shifting circuit MK-1 is not supplied with this equipment. It can be fabricated from the schematic diagram, figure 5-2, or purchased from Polarad Electronics Corporation.

(2) Connect one end of the coaxial crystal mount, with dc return to the vertical input of a high gain oscilloscope, and the opposite end to the coaxial-to-waveguide adapter.

(3) Connect a coaxial-to-waveguide adapter to the MSG-34 and place a reaction type frequency meter having an accuracy of 0.1% or better between the two adapters.

(4) Refer to table 5-2 for the equipment needed at the different frequency ranges.

c. CONTROL SETTINGS FOR MSG-34.

TABLE 5-2. TEST EQUIPMENT REQUIRED FOR REPELLER TRACKING PROCEDURE.

| FREQUENCY RANGE | OSCILLOSCOPE | COAXIAL CRYSTAL MOUNT | REACTION TYPE FREQUENCY METER ACCURACY OF 0.1% OR BETTER | COAXIAL-TO-WAVEGUIDE ADAPTER |
|---|---|---|---|---|
| 4.00 to 5.85 KMC | Dumont 304A | HP420A | PRD-574<br>3.95-5.85 KMC | PRD-357 |
| 5.85 to 8.20 KMC | Dumont 304A | HP420A | HP-J530A<br>5.85-8.2 KMC | HP-J281A |
| 8.20 to 11.0 KMC | Dumont 304A | HP420A | HP-X530A<br>8.2-12, 4 KMC | HP-X281 |
| ADJUSTMENT OF THE REPELLER TRACKING CIRCUIT DURING INT. PULSE MODULATION REQUIRES THE USE OF THE FOLLOWING EQUIPMENT. | | | | |
| 4.00 to 11.0 KMC | TEKTRONIX 531A | HP420A | As above for the various ranges. | As above for the various ranges. |

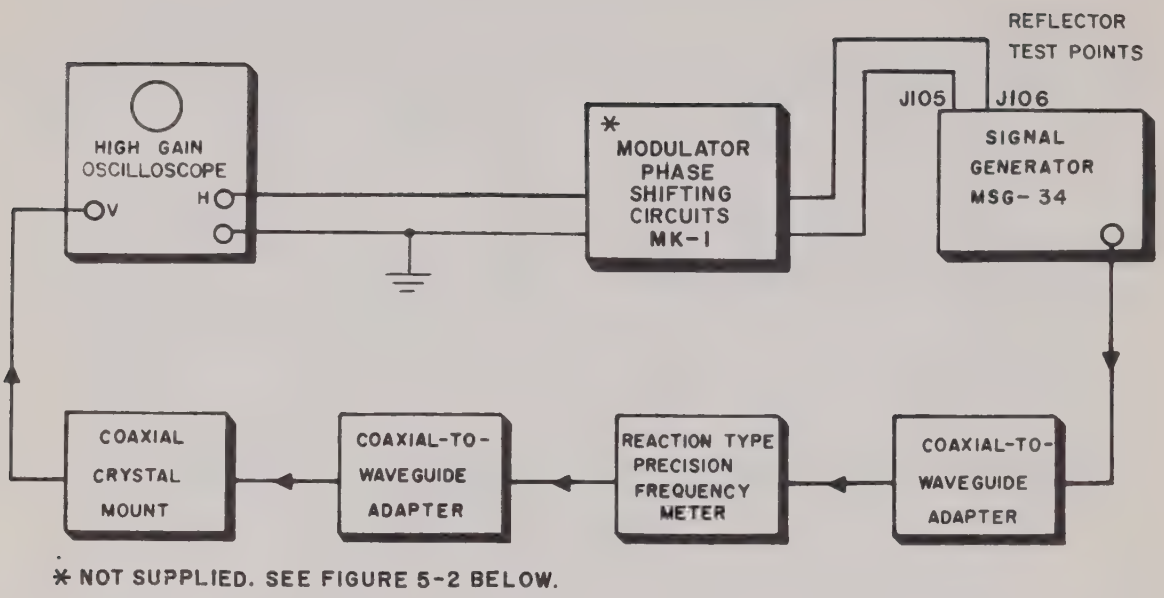



Figure 5-1. Repeller Voltage Tracking, Test Set-Up

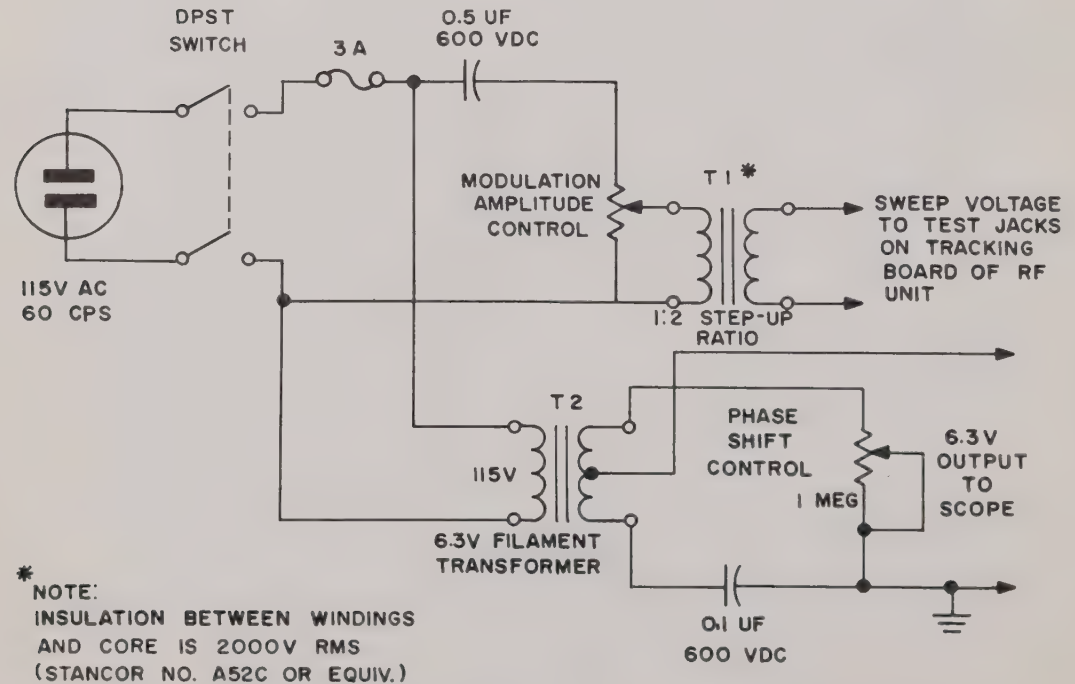



Figure 5-2. Modulator Phase Shifting Circuit, MK-1, Schematic Diagram

(1) With MODULATION SELECTOR S203 at its CW position, apply operating power to the signal generator, and allow at least a 20-minute warmup period.

(2) Rotate the SYNC. & POLARITY SELECTOR switch S201 to its INT. MOD. SQ. WV. position.

d. TRACK POTENTIOMETER ADJUSTMENTS (CW).

(1) After the test equipment has been set up and the controls set as directed above, connect the negative lead of a 20,000-ohm-per-volt meter to the repeller connection J105, and the positive lead to pin 3 of tracking potentiometer R101. Proceed as follows:

| STEP | Set Frequency Dial to: | Indication | | If indication is not correct rotate |
|---|---|---|---|---|
| | | Voltage* | Mode | |
| 1 | 11000 mc | 270V | At center of trace | Potentiometer R106 |
| 2 | 4200 mc | 40V | At center of trace | Potentiometer R102 |
| 3 | Rotate dial toward the low end until a click is heard at approximately 7700 to 8000 mc. Reverse the dial rotation and stop as the second click is heard. | 125V | At center of trace | HIGH MODE Potentiometer R108 |
| 4 | Rotate the dial toward the low end. Stop the dial when click is heard. | 500V | At center of trace | LOW MODE Potentiometer R107 |
| 5 | 9600 mc | 210V | At center of trace | Track 3, R105 |
| 6 | 6700 mc | 370V | At center of trace | Track 2, R104 |
| 7 | 5300 mc | 200V | At center of trace | Track 1, R103 |

* Approximate. There may be a variation of ±10% due to difference in klystron tubes.

(2) Re-check the repeller voltages at the high and low dial frequencies by repeating steps 1 and 2 above. Then check the intermediate tracking points.

**NOTE**

If the klystron has been replaced, the above procedure should afford correct repeller tracking. Failure to track properly may indicate a defective replacement klystron.

(3) The repeller voltage must now be rechecked, as directed above, because of the interacting effects of the adjustments. Minor adjustments are to be made, as necessary, to complete the alignment procedure, with the signal generator producing continuous-wave output signals.

e. TRACK POTENTIOMETER ADJUSTMENTS (PULSE-MODULATED OUTPUT.)

The repeller voltage tracking must now be rechecked throughout the tuning range. Proceed as follows:

(1) Rotate MODULATION SELECTOR switch to its INT. PULSE position.

(2) Set SYNC. & POLARITY SELECTOR switch to its INT. MOD. SQ. WV. position.

(3) Set FREQUENCY MULTIPLIER and FREQUENCY CYCLE PER SECOND control to produce a pulse repetition frequency of approximately 1,000 PPS.

(4) Now check for pulse modulated output throughout the frequency range.

## 5-3. Tracking Adjustment after Replacement of a Track Potentiometer

After replacement of one of the track potentiometers, R102 through R106, set the arm of the new potentiometer to the center of its travel and proceed as directed in paragraph 5-2.

**NOTE**

If trouble is experienced in the alignment of the repeller tracking circuit, it may be localized, by measuring the voltage between test points J105 and J106. The voltage should be 600 volts dc.

### 5-4. Frequency Dial Calibration

a. Connect the test setup and equipment as described in paragraph 5-2b, using the test equipment indicated in table 5-2. If the accuracy of the dial falls outside the 1% tolerance at any point over the tuning range, fine adjustments are made by means of the adjustable tuning cam. (See figure 5-4.) Five eccentric bolts and nuts on the cam are to be adjusted, as described below:

b. Turn the RF OSC. knob so that the cam follower is at the fixed section of the tuning cam, adjacent to the two small holes which terminate the arc on the cam. Tune the wavemeter to 7840 mc. The FREQUENCY dial will be at this frequency.

c. A mode pattern should appear on the oscilloscope. A dip should appear at the center of the mode pattern if the oscillator output is at 7840 mc.

d. Frequency correction is made by adjusting the push-rods which are part of the choke assembly. This is the ONLY time the push-rods will be adjusted. Use a Spline wrench (supplied) to loosen the three set screws on the push-rod disc. See figure 4-9. GENTLY and SLOWLY move the push-rods up or down, so that the oscillator frequency changes enough to move the dip to the center of the mode pattern. (See figure 5-3). Once the dip is centered, a reference point has been established on the cam with respect to the dial. Tighten set screws once this is accomplished. Recheck for dip centering on mode.

e. TUNING CAM ADJUSTMENTS.

The remainder of the oscillator frequency range is next calibrated. This is accomplished by using the five adjustment bolts located along the periphery of the cam. (See figure 5-4). Since the bolts are offset, adjusting them slightly alters the shape of the periphery of the cam.

**CAUTION**

NEVER ATTEMPT TO ADJUST ANY BOLT ON THE TUNING CAM, UNLESS ALL BOLTS ON THAT SECTION OF THE CAM ARE FIRST LOOSENED. FAILURE TO OBSERVE THIS PRECAUTION WILL RESULT IN STRIPPING THE RIVETS THAT SECURE THE TAB CAMS TO THE CAM.

(1) Rotate RF OSC. knob until FREQUENCY dial reads 9540. The cam follower will be directly opposite eccentric adjustment no. 4.

(2) To determine the oscillator frequency, set the wavemeter to the above frequency. If the wavemeter dip is not in the center of the mode pattern, adjusting the bolts will shift the mode pattern slightly.

(3) This procedure is repeated at each of the five adjustment bolts as listed below in the following order:

2nd step: Eccentric No. 5 - 11,000 mc.
3rd step: Eccentric No. 3 - 6,400 mc.
4th step: Eccentric No. 2 - 5,060 mc.
5th step: Eccentric No. 1 - 4,200 mc.

(4) After making each adjustment, tighten each tuning cam nut, using two open-end wrenches throughout the procedure. Both the hex-head nuts and bolts are 5/16 inches wide across the flats.

(5) After the last adjustment has been made, recheck the previous four adjustments to be sure that they have not been disturbed by subsequent adjustments. Then check calibration of the oscillator at 25 mc intervals through the entire frequency range. If all points are within 0.5% of wavemeter readings, the oscillator is correctly calibrated.

### 5-5. Setting the LOW FREQ ADJ R217

To set the LOW FREQ ADJ R217, proceed as follows:

a. Connect the signal generator as shown in figure 5-5A. Turn power on and allow fifteen minutes warm-up.

b. Set FREQUENCY MULTIPLIER on X10 position.
Set FREQUENCY CYCLE PER SECOND control on 1.
Set MODULATION SELECTOR switch to INT. PULSE position.
Set SYNC. & POLARITY SELECTOR to INT. MOD. SQ. WV. position.

c. If the pulse repetition rate does not fall on 10 cps, it may be adjusted to 10 cps by resetting the LOW FREQ ADJ R217. The high end of the repetition rate range will automatically fall in and track correctly.

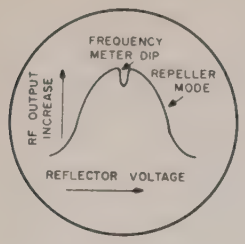
### 5-6. Setting the SYMMETRY ADJ R211

To adjust the square wave SYMMETRY ADJ R211, proceed as follows:

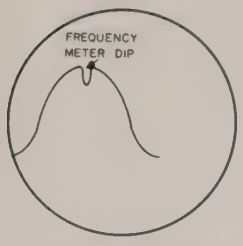
a. Set the MODULATION SELECTOR switch to INT. SQ. WV. position.
Set the FREQUENCY MULTIPLIER TO X1000 position.
Set the FREQUENCY CYCLE PER SECOND control on 5.
Set the SYNC. & POLARITY SELECTOR switch to INT. MOD. SQ. WV. position.

b. Using a coaxial crystal detector, feed the detected rf output signal to a Tektronix model 531 oscilloscope (see figure 5-5B).

c. Adjust SYMMETRY ADJ R211 until the pulse width on oscilloscope is 50% of the repetition rate or on and




MODE PATTERN CENTERED




MODE PATTERN NOT CENTERED

PHASE SHIFT CONTROL IMPROPERLY ADJUSTED

Figure 5-3. Typical Mode Patterns

off periods are equal.

Lock shaft in the desired position by tightening the locknuts. Recheck symmetry of square wave.

### 5-7. Setting the MIN DELAY ADJ R233

To adjust the MIN DELAY ADJ R233 (figure 5-5C), proceed as follows:

a. Set MODULATION SELECTOR switch to INT. PULSE position.
Set SYNC. & POLARITY SELECTOR switch to INT. MOD. SQ. WV. position.
Set DELAY MULTIPLIER to X1.
Set DELAY MICROSECONDS to 2.

b. Trigger the oscilloscope with the UNDELAYED SYNC. output. Feed the DELAYED SYNC. to the vertical input on the oscilloscope.

c. Adjust the MIN DELAY ADJ R233 for 2 microseconds spacing between the undelayed and delayed triggers. Lock shaft in the desired position by tightening the locknut. Recheck MIN DELAY after locking.

d. R238 is factory adjusted. If adjustment is required due to the absence of a delayed sync pulse output, then adjust R238 to the point where Blocking Osc. V206B conducts but does not free-run.

### 5-8. Setting the MIN WIDTH ADJ R315

To adjust the MIN WIDTH ADJ R315 (figure 5-5D), proceed as follows:

a. Set the unit for internal pulse operation.
Set PULSE WIDTH control to 0.2 microsecond.

b. Couple rf output and display on Tektronix model 531 oscilloscope, using a Hewlett-Packard 420A coaxial crystal detector with 250 ohm termination.

c. Adjust the MIN WIDTH ADJ R315 for 0.2 microsecond. Lock shaft in the desired position by tightening the locknut. Recheck pulse width after locking.

### 5-9. Setting the BIAS ADJ R309

R309 controls the grid bias of multivibrator V211, and is factory adjusted. If readjustment is required, R309 should be set so that there is approximately 20 volts on the grid of V211 and so that the pulse does not free-run or break up in any way. A good clean pulse should be observed on the oscilloscope at both the grid and plate of V211.

### 5-10. Setting the BIAS ADJ R131

R131 controls the grid bias of pulse amplifier V107. If readjustment becomes necessary, the control should be set so that the pulse or square wave does not free-run or break up when the modulation selector switch is in the INT PULSE, INT SQ WAVE, or FM positions.

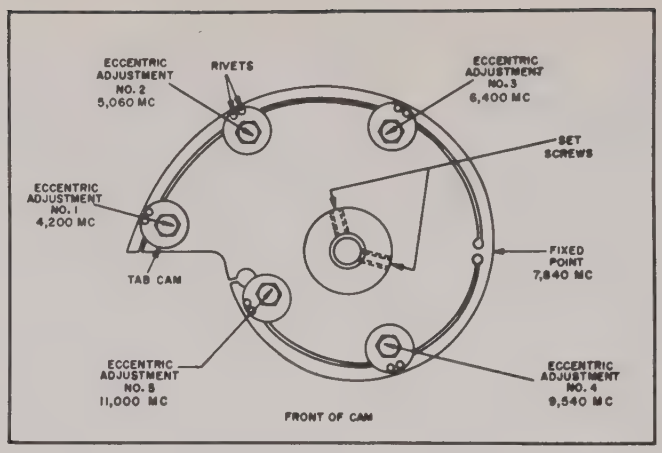

ECCENTRIC ADJUSTMENT NO. 2 5,060 MC
RIVETS
ECCENTRIC ADJUSTMENT NO. 3 6,400 MC
SET SCREWS
ECCENTRIC ADJUSTMENT NO. 1 4,200 MC
FIXED POINT 7,840 MC
TAB CAM
ECCENTRIC ADJUSTMENT NO. 5 11,000 MC
ECCENTRIC ADJUSTMENT NO. 4 9,540 MC
FRONT OF CAM

Figure 5-4. Oscillator Adjustable Tuning Cam, Component Location Diagram

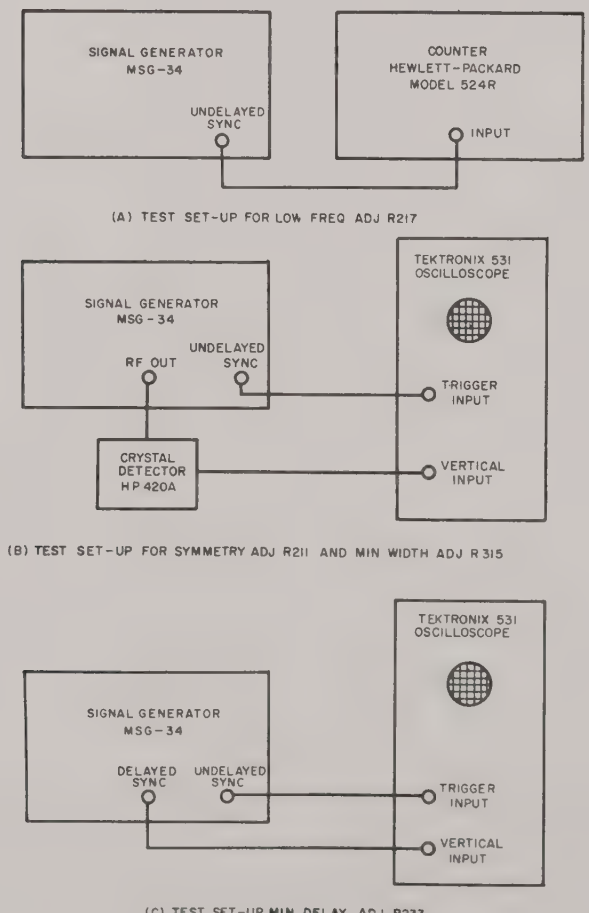
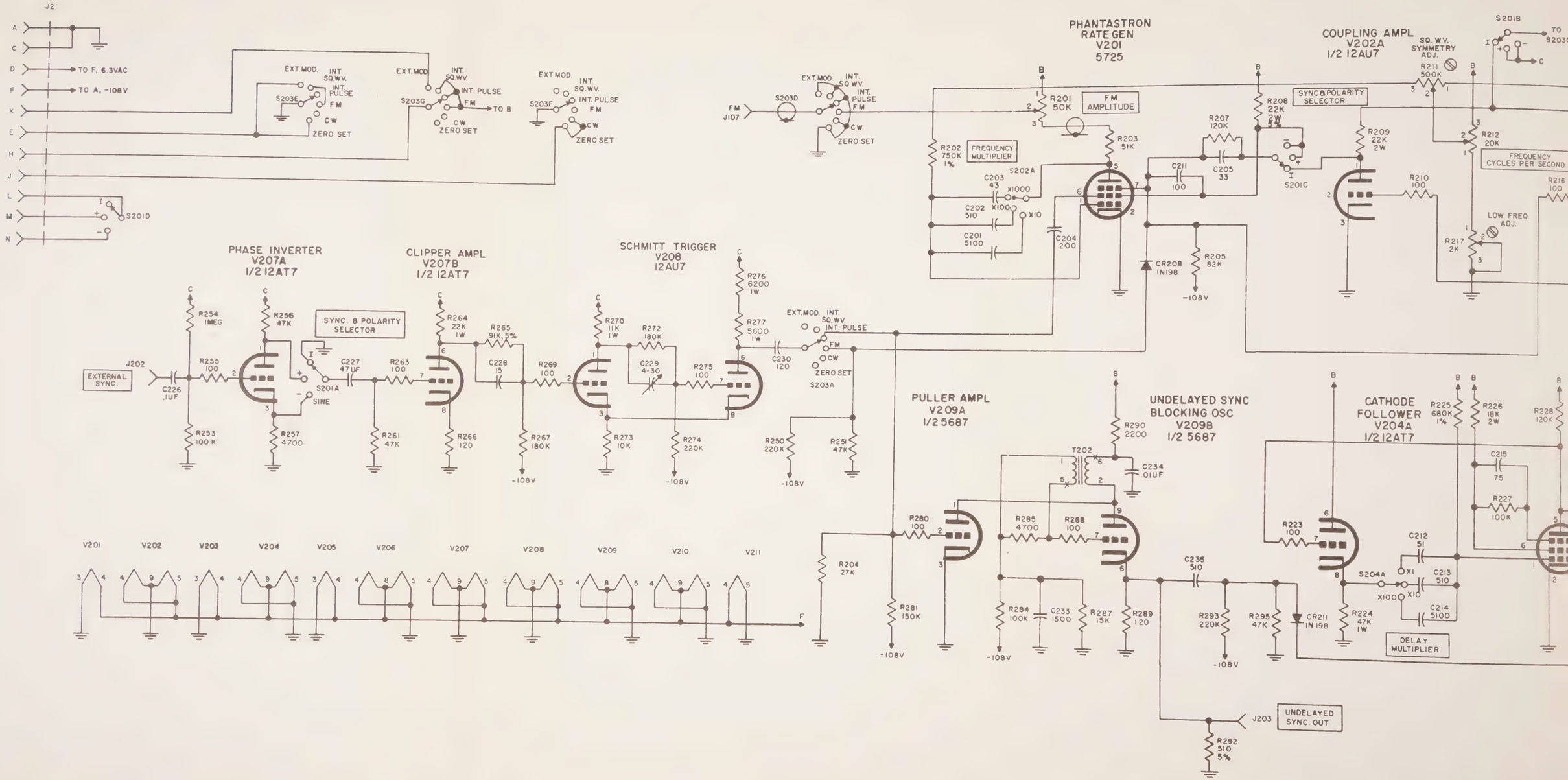
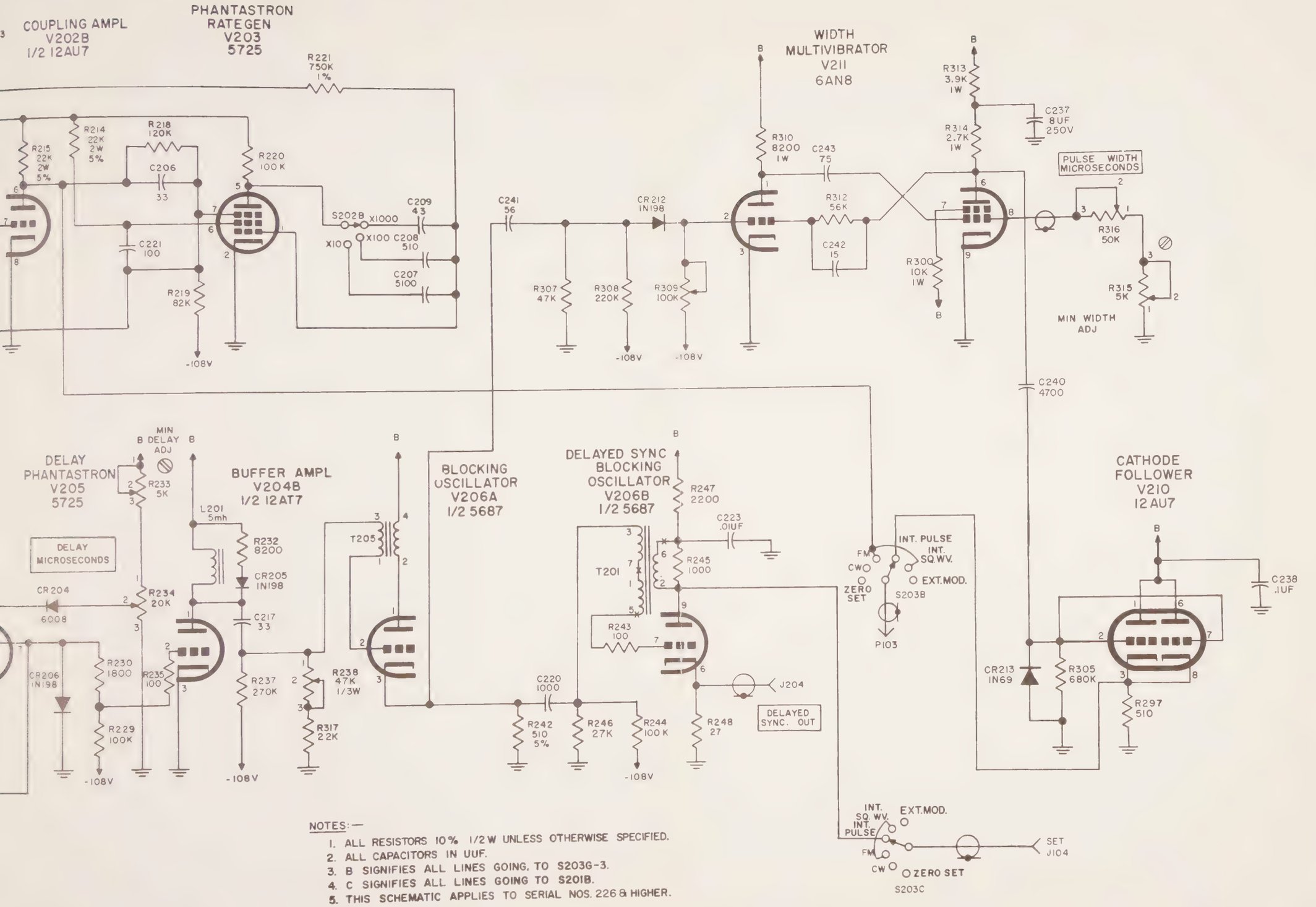



Figure 5-5. Adjustments, Test Set-Up


J2
A
C
D
TO F, 6.3VAC
F
TO A, -108V
X
E
H
J
L
M
N
S201D
EXT. MOD.
INT. SQ.WV.
INT. PULSE
FM
CW
ZERO SET
S203E
S203G
TO B
S203F
PHANTASTRON RATE GEN V201 5725
FM J107
S203D
R201 50K
FM AMPLITUDE
R202 750K 1%
FREQUENCY MULTIPLIER
R203 51K
S202A
C203 43
X1000
C202 510
X100
X10
C201 5100
C204 200
R207 120K
C211 100
C205 33
R208 22K 2W 5%
S201C
SYNC & POLARITY SELECTOR
R209 22K 2W
COUPLING AMPL V202A 1/2 12AU7
SQ. WV. SYMMETRY ADJ.
R211 500K
R212 20K
FREQUENCY CYCLES PER SECOND
R210 100
R216 100
LOW FREQ. ADJ.
R217 2K
S201B
TO S203
CR208 1N198
R205 82K
-108V
PHASE INVERTER V207A 1/2 12AT7
CLIPPER AMPL V207B 1/2 12AT7
SCHMITT TRIGGER V208 12AU7
J202
EXTERNAL SYNC.
C226 .1UF
R254 1MEG
R255 100
R253 100 K
R256 47K
R257 4700
SYNC. & POLARITY SELECTOR
S201A
SINE
C227 47UF
R263 100
R261 47K
R264 22K 1W
R265 91K, 5%
C228 15
R266 120
R267 180K
R269 100
R270 11K 1W
R272 180K
C229 4-30
R273 10K
R275 100
R274 220K
R276 6200 1W
R277 5600 1W
C230 120
R250 220K
R251 47K
S203A
PULLER AMPL V209A 1/2 5687
R280 100
R204 27K
R281 150K
UNDELAYED SYNC BLOCKING OSC V209B 1/2 5687
T202
R290 2200
C234 .01UF
R285 4700
R288 100
R284 100K
C233 1500
R287 15K
R289 120
C235 510
R293 220K
R295 47K
CR211 1N198
CATHODE FOLLOWER V204A 1/2 12AT7
R225 680K 1%
R226 18K 2W
R228 120K
C215 75
R227 100K
R223 100
S204A
X1
X10
X100
C212 51
C213 510
C214 5100
R224 47K 1W
DELAY MULTIPLIER
J203
UNDELAYED SYNC. OUT
R292 510 5%
V201
V202
V203
V204
V205
V206
V207
V208
V209
V210
V211
F




NOTES:—

1. ALL RESISTORS 10% 1/2W UNLESS OTHERWISE SPECIFIED.
2. ALL CAPACITORS IN UUF.
3. B SIGNIFIES ALL LINES GOING TO S203G-3.
4. C SIGNIFIES ALL LINES GOING TO S201B.
5. THIS SCHEMATIC APPLIES TO SERIAL NOS. 226 & HIGHER.

Figure 5-6. MSG-34 Modulator Schematic Diagram

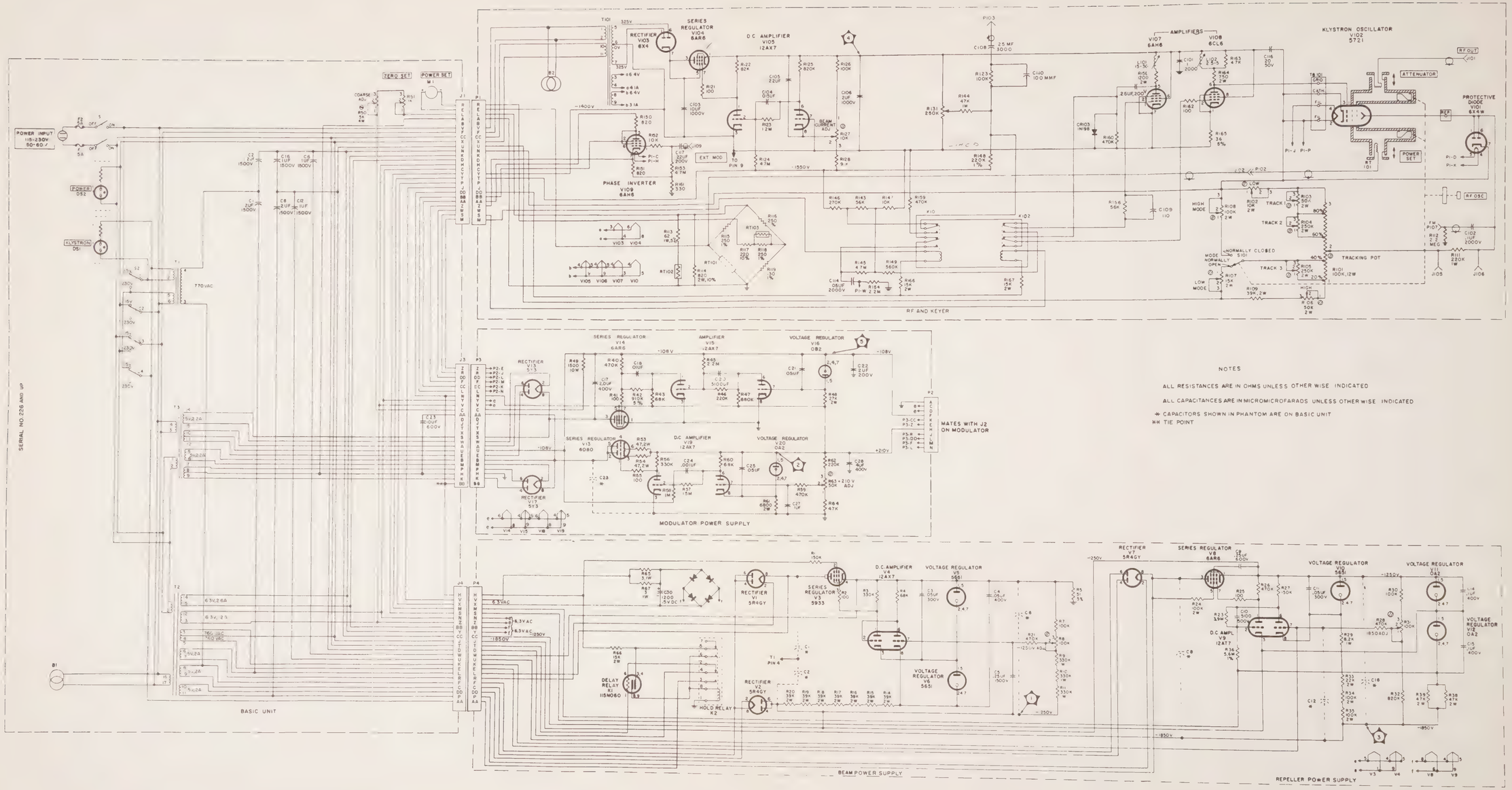



Figure 5-7. MSG-34 Overall Schematic Diagram, Less Modulator

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CONSULTANTS — DESIGNERS — MANUFACTURERS

43-20 34th Street Long Island City 1, N. Y.

EXeter 2-4500


## REQUEST FOR MAINTENANCE

FROM:

COMPANY NAME _____ DATE: _____

ADDRESS: _____ INDIVIDUAL _____

_____ POSITION _____

SECTION OR DIVISION _____ PHONE NO. _____ EXT. _____

_____

EQUIPMENT _____ DATE OF PURCHASE _____

MODEL _____ SERIAL NO. _____ ORDER NO. _____

_____

TROUBLE REPORT:

A. Description of trouble _____

_____

_____

_____

_____

_____

B. Has trouble been localized? _____ If so, how and where: _____

_____

_____

_____

_____

_____

_____

C. Instruments used and measurements taken, if any: _____

_____

_____

_____

D. Is trouble intermittent? _____

E. Hours of operation prior to this trouble _____

F. Date trouble occurred _____

G. Was factory consulted by telephone or letter prior to this request? _____

If so, give date and person to whom directed: _____

_____

H. Additional Comments: _____

_____

_____

_____

_____

_____

_____

When trouble develops requiring factory assistance, complete this form and send to:

Polarad Electronics Corporation
43-20 34th Street
Long Island City 1, New York
ATTENTION: Service Department

After this report has been analyzed by the Service Department, you will be notified when a field service engineer will call on you to make the necessary repairs. If your trouble can best be corrected at the factory, we will so notify you with instructions and authorization for returning the equipment.

**NO EQUIPMENT MAY BE RETURNED TO THE FACTORY WITHOUT WRITTEN AUTHORIZATION**

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Portland, Oregon
Belmont 4-9375

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Room 107 Administration Bldg
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Seattle, Washington
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